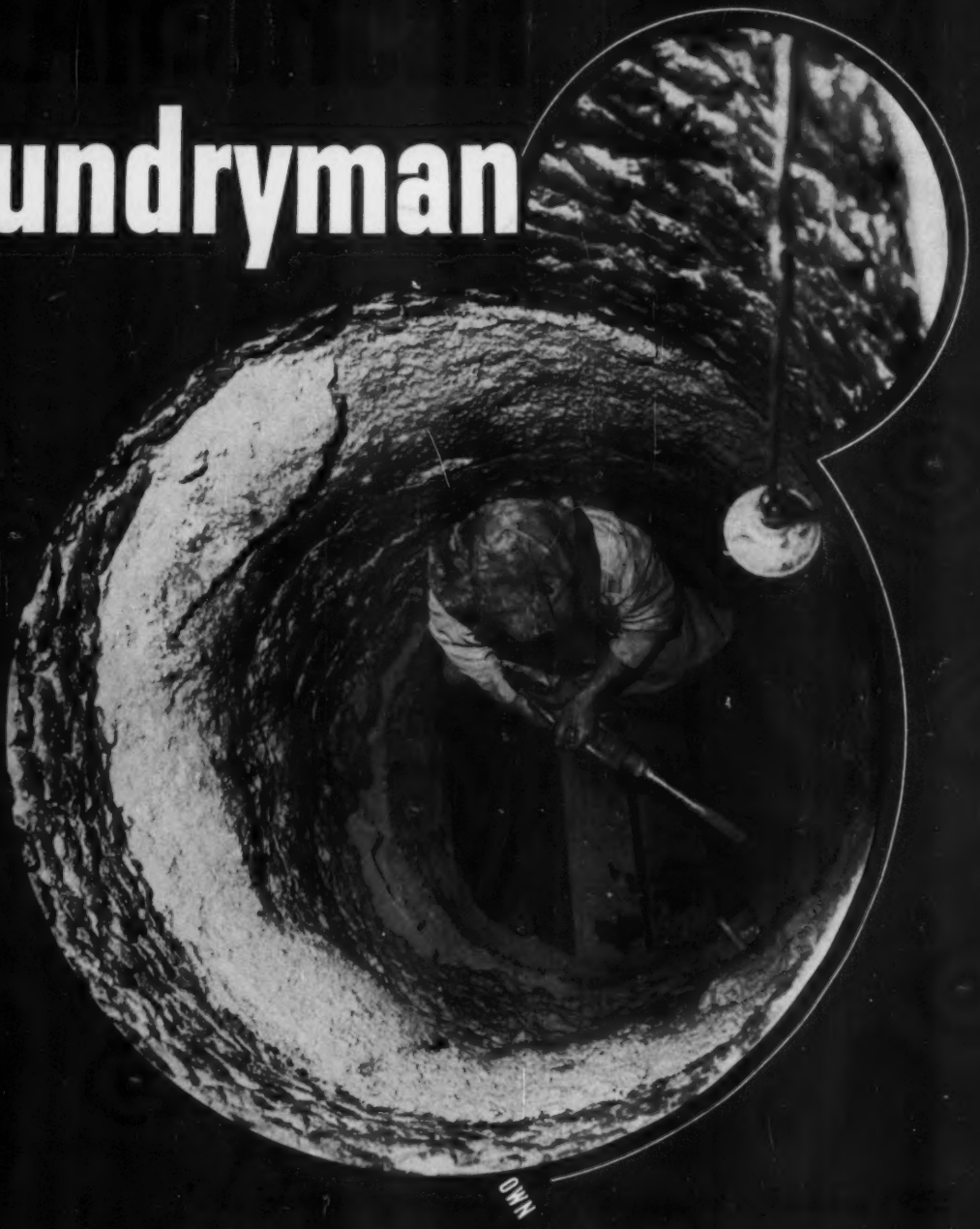
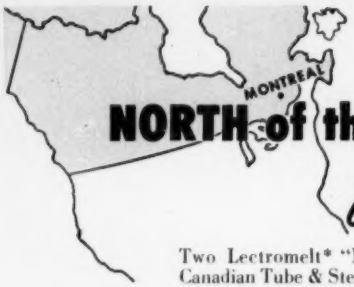
Foundryman





NORTH of the border...it's Lectromelt, too!

for fast low-cost melting

Two Lectromelt* "M-T" furnaces give Canadian Tube & Steel Products, Limited, of Montreal laborsaving top charging that spells major economies in metals melting.

Canadian steel men have known Lectromelt for years—recognize that Lectromelt furnaces give you all these features:

- Top-charging design that saves man-hours, cuts electrode consumption, saves power, lengthens lining life.
- Counterbalanced electrode arms.
- Power supply and regulation equipment engineered for every installation.
- Separately mounted roof lift and swing mechanism.
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- Completely factory-assembled and mechanically operated.

A furnace with all these features will cost a lot less in the long run. Pittsburgh Lectromelt Corporation. 316 32nd Street, Pittsburgh 30, Pennsylvania.

Manufactured in . . . CANADA: Lectromelt Furnaces of Canada, Ltd., Toronto 2 . . . ENGLAND: Birlec, Ltd., Birmingham . . . AUSTRALIA: Birlec, Ltd., Sydney . . . FRANCE: Stein et Roubaix, Paris . . . BELGIUM: S. A. Belge Stein et Roubaix, Brassoux-Liege . . . SPAIN: General Electrica Espanola, Bilbao . . . ITALY: Forni Stein, Genoa.

*REG. T. M. U. S. PAT. OFF.

WHEN YOU MELT... MOORE RAPID *Lectromelt*

TOMORROW'S CORE BLOWER . . . TODAY!

Federal presents the
NEW FULL-AUTOMATIC "SAN-BLO"

The NEW FOR '52 "SAN-BLO" — the fastest, most efficient core blower! Time consuming, manual operations are performed by electric controls, described below. Complete operation of blowing cycle is reduced to simply pressing one starting button—the controls do the rest. The amazing new controls are *plus* features, in addition to SAN-BLO's motor-driven plows and aerating air circuit. These exclusive design features made possible for the first time the successful blowing of *any* core sand that could be hand-rammed, and blowing *any* size core up to 40 lbs. without changing sand magazine.

BLOWS 10 LB. CORES IN 2½ SECONDS—40 LB. CORES IN 5 SECONDS

In only 2½ seconds from the time the starting button is pressed, a uniform, accurate 10 lb. core is ready to be taken from the machine. In only 5 seconds, a 40 lb. core. The ultimate in fast production of high quality cores made from any core sand mixture.

AUTOMATIC, ELECTRICALLY-TIMED FILLING OF SAND MAGAZINE

The large sand magazine does *not* require refilling after each blow. An electric counter controls automatic refilling. At intervals, depending on size of core being blown, magazine automatically swings back under hopper, fills and returns to blowing position. Motor-driven agitator in sand hopper provides immediate filling of sand magazine, and operates only when magazine is in filling position.

AUTOMATIC, ELECTRICALLY-CONTROLLED BLOWING CYCLE

An electric timer, graduated in seconds, provides correct timing of the blowing cycle. Size of core and type of sand being blown govern setting of timer. Fixing the time of the blowing cycle assures a steady production of uniform cores.

MECHANICAL MOVEMENT OF SAND IN SAND MAGAZINE

Motor-driven plows, which operate only during blowing cycle, revolve in lower part of sand magazine, move sand mechanically to blow hole and keep an even distribution of sand over entire blow plate. No "piping" or "bridging" in sand magazine at any time. An "aerating" air circuit feeds air, under full pressure, through a fine mesh screen which forms the lower inner wall of the sand magazine. By aerating the sand and moving it mechanically, SAN-BLO can blow *all* types of core sand and blow them to uniform hardness.

AUTOMATIC DRAWING OF CORE FROM COPE OF CORE BOX

An air-oil controlled clamping table, with 6" stroke, provides vertical clamping of core box. By fastening the cope half of core box to blow plate and blowing into a drier, core can be drawn from the cope. By setting up a conveyor system at rear of machine, cores on driers can be ejected as empty driers are inserted in blowing position from the front.

- **Quick Job Changes**
  One adjustment wheel quickly raises or lowers sand magazine to accommodate core box. Sand magazine is standard — is never changed.
- **Wide Range of Core Boxes**
  The SAN-BLO will blow all cores from the smallest to those weighing 40 lbs. each—and blow them all from its one standard sand magazine.
- **80% Sand Delivery**
  The SAN-BLO blows 40 to 42 lbs. of its 50 lb. magazine load because sand is moved mechanically to the blow hole. No "piping" or "bridging".
- **Automatic Safety Features**
  Air pressure is cut off automatically while sand magazine is being refilled. Blowing cycle cannot start unless the core box is in blowing position.

Write for new Bulletin CB-3

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THE FEDERAL FOUNDRY SUPPLY COMPANY

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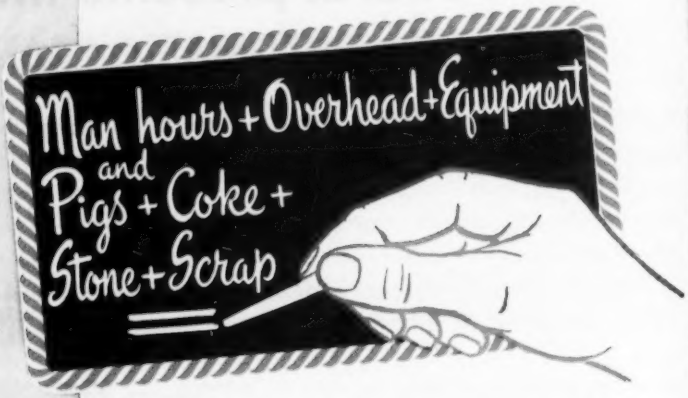
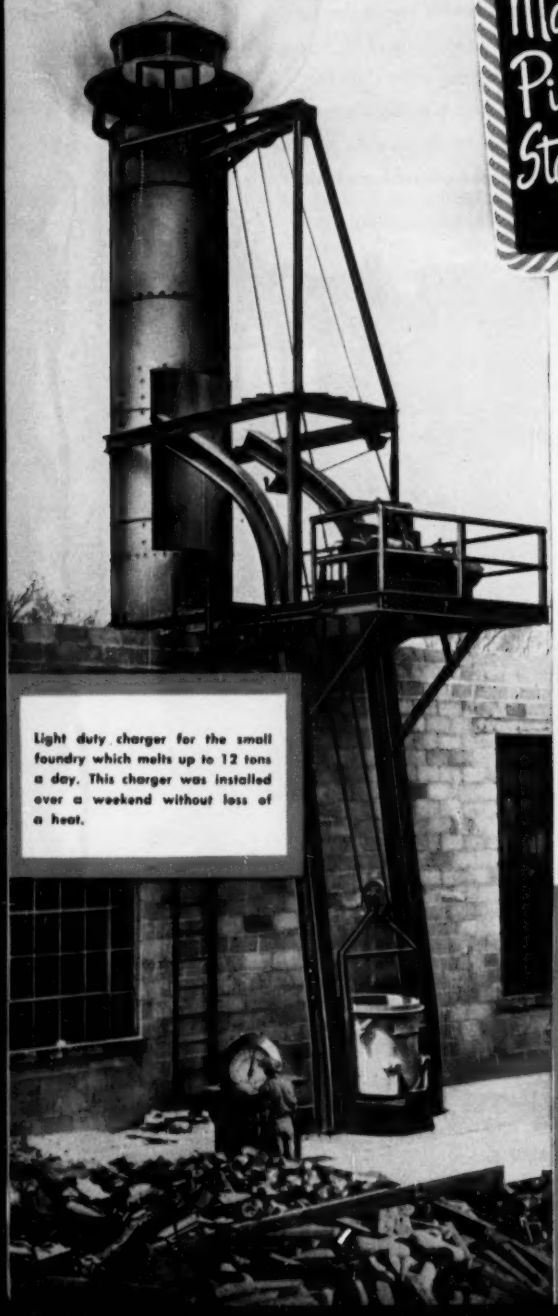
SCALING DOWN CHARGING COSTS...
and making up a charge at the scale...
are figured over two standard formulas...





Light duty charger for the small foundry which melts up to 12 tons a day. This charger was installed over a weekend without loss of a heat.

equal greater over-all profits when charging is done mechanically.

Relieved of much back-breaking work fewer yard-men are needed to control the automatic charging equipment. And through closely WORKING TOGETHER with practical foundrymen MODERN engineers have developed this moderate-priced charger specially for the small foundry. Hotter, more uniform metal reduces the volume of waste. Fewer lost time accidents help to keep men on the job. For all the facts and figures on this type of charging, for the small foundry, write for catalog 147-A.

Complete information on cupola charging will be mailed, along with catalog 147-A, to foundry executives who outline a problem on their company letterhead. Use the coupon for catalog only.

MODERN EQUIPMENT CO.

PORT WASHINGTON, WISCONSIN
Dept. AF-1-53

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ABC

JANUARY, 1952

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January, 1952

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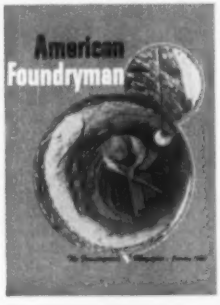
The American Foundrymen's Society is not responsible for statements or opinions advanced by authors of papers in its publication.



Charging-door view of installation of monolithic cupola lining by air placement. Operator has chipped out slag and damaged refractory around tuyeres, tap hole, and slag hole and is ready to blow in the granular refractory and water. Pipe in lower right hand portion of picture will form slag hole. Air placement guns are being used for lining both basic and acid cupolas.

Published monthly by the American Foundrymen's Society, Inc., 616 S. Michigan Ave., Chicago 5. Subscription price in the U. S., Canada and Mexico, $3.00 per year; elsewhere, $6.00. Single copies, 50. Entered as second class matter July 22, 1938, under Act of March 3, 1879, at the Post Office, Chicago, Illinois. EASTERN REPRESENTATIVE—C. A. Larson & Associates, 254 West 31st St., New York 1, N. Y. CENTRAL REPRESENTATIVE—R. E. Cleary, Commercial & Savings Bank Bldg., Berea, Ohio. MIDWESTERN—H. Thorpe Covington Co., 677 N. Michigan Ave., Chicago, Ill.

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LINK-BELT Sand Revivifiers and Sep-Aerators assure flowability . . . cut sand preparation costs by thorough aeration

Here's a simple, economical way to cut down scrap. Link-Belt Sand Revivifier gives you an aerated, fluffy sand with corresponding drop in temperature, that flows easily around every corner of the pattern . . . rams to a uniform density every time.

In non-ferrous foundries, the Link-Belt Sep-Aerator removes metallic shot by centrifugal action. Both are well engineered, standardized units built for many years of service.

For full information, call the Link-Belt office near you. A foundry specialist will be glad to work with you or your consultants to help you increase production in your foundry.

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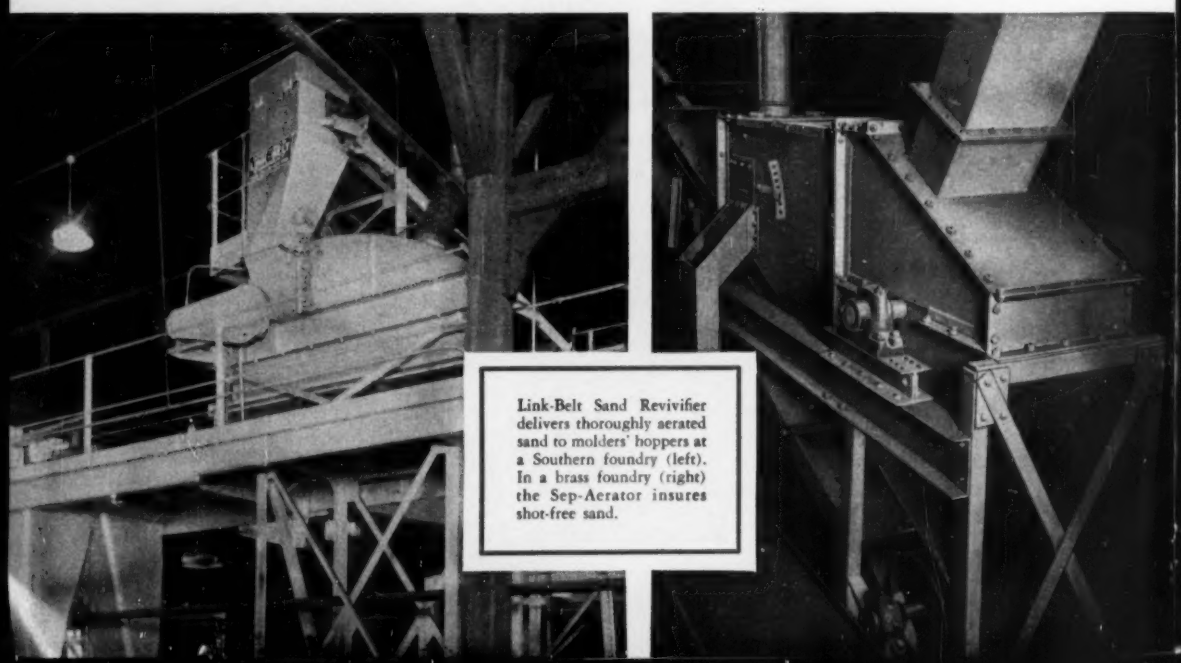
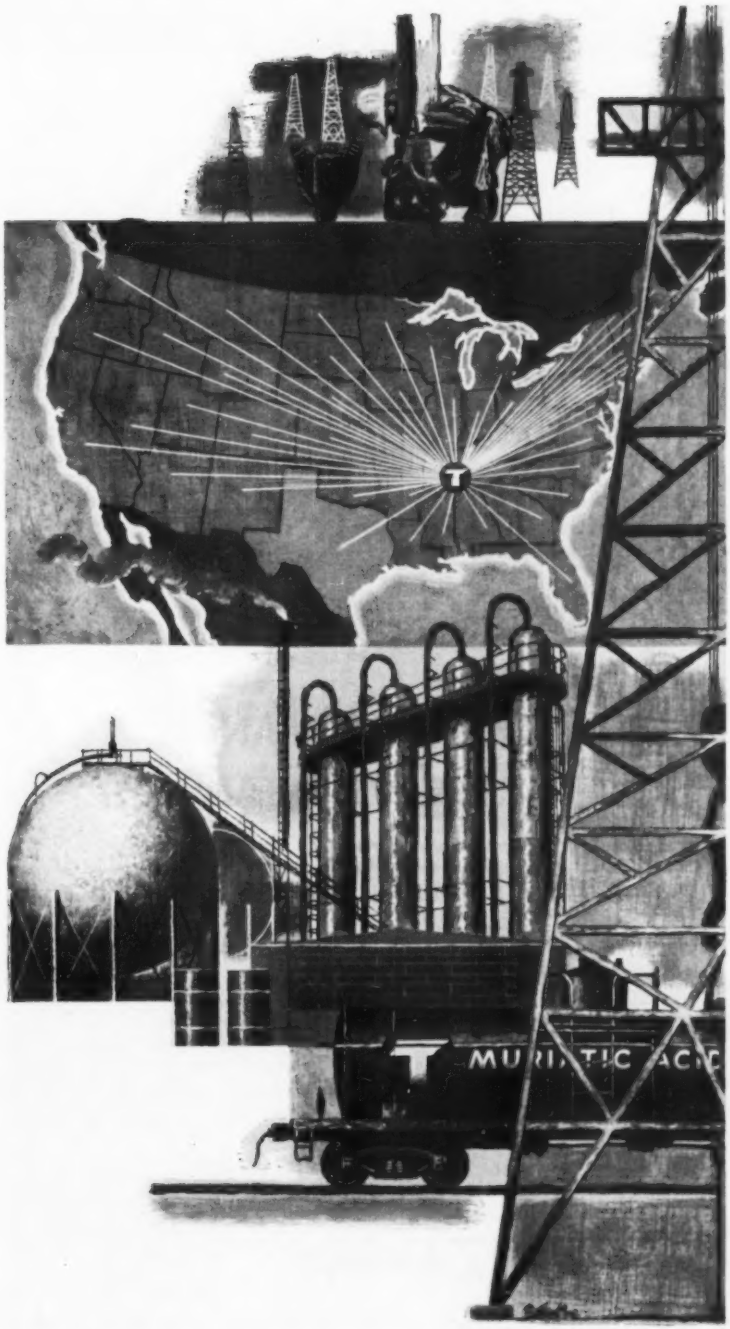


Link-Belt Sand Revivifier delivers thoroughly aerated sand to molders' hoppers at a Southern foundry (left). In a brass foundry (right) the Sep-Aerator insures shot-free sand.

THERE'S A TOUCH OF TENNESSEE IN TEXAS OIL



Oil has brought great wealth to the Lone Star State, to Oklahoma, Pennsylvania, Illinois, Louisiana, California, and other oil producing states. Products from Tennessee are important to the oil industry wherever it is... Tennessee's Muriatic Acid for acidizing the wells, pig iron and ferro alloys for hard drill bits, strong derricks, tank cars and durable pipe.

Many other products from Tennessee are used by Texas industries... Acetic Acid for photographic and bleaching processes... Benzene Hexachloride for pesticides to protect cotton crops... Sodium Benzoate as a preservative. In fact, Tennessee's products are used by key industries in every state in the union. That's why Tennessee is known from Coast to Coast as an industry serving all industry.

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PRODUCTS & CHEMICAL
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NASHVILLE, TENNESSEE

Producers of: FUELS • METALLURGICAL PRODUCTS • TENSULATE BUILDING PRODUCTS • AROMATIC CHEMICALS WOOD CHEMICALS • AGRICULTURAL CHEMICALS

THE **FEDERATED** SALESMAN IS **YOUR** REPRESENTATIVE...

It is important in times of metal shortage that you should have such a representative. Metal is often your problem nowadays. Supplying it is Federated's problem.

Maybe the metal isn't available. Maybe it's absorbed by earlier orders.

Still, *your* business—small or large—is represented at Federated headquarters by *your* Federated salesman. His job is to bring your need to his home office.

If Federated can supply the alloy, you'll get it. If not, Federated metallurgists will study and plan and test and name an alloy that you can use in place of your old standby . . . a Herculoy* silicon bronze, for example, to replace high tin bronze, giving you superior physical and casting properties.

In any case, remember your Federated salesman . . . it's his job to help you solve shortage and other foundry problems, and he has a big laboratory and field staff to help him do it.

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Federated first in the non-ferrous field FMD

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IMPORTANT!
Two motion picture films —one on the use of Chaplets, the other on the use of Chills — are available, free of charge, for showing at Foremen Club meetings, in technical schools, A. F. S. chapter meetings, etc. Write for reservation.

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BETTER CASTINGS

Birdseye view of the Fanner Brookside Park Plant in Cleveland

More than 50 years of sound basic Chaplet and Chill designing for specific needs plus metallurgically correct materials give Fanner Chaplets and Chills an unmatched record in the reduction of scrap losses. Added economies are also effected because the Fanner line includes many as "standards" priced elsewhere as "specials".

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DELTA NO-VEIN COMPOUND

EVERY DELTA Foundry Product is backed by continuing and exhaustive laboratory research to safeguard quality and maintain absolute uniformity. From raw materials to the finished product manufacturing processes proceed under an automatic and persistent policy of laboratory control.

DELTA FOUNDRY PRODUCTS CUT PRODUCTION COSTS

CORE AND MOLD WASHES:
FOR ALL TYPES OF SAND CAST METALS: STEEL, GRAY IRON, MALLEABLE AND NON-FERROUS.

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PARTING COMPOUNDS

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96-B SAND RELEASE AGENT

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CORE ROD DIP OIL NO. 224X

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SAND CONDITIONING OIL

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CORE OILS

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Ends VEINING AND METAL PENETRATION IN YOUR CORE SAND MIXES

Add only a small quantity of DELTA NO-VEIN COMPOUND (1% to 3% maximum) to your core sand and eliminate troublesome veining of cores.

DELTA NO-VEIN COMPOUND is a specially prepared and compounded series of oxides which develop the necessary plasticity and hot strength without, in any way, deteriorating the sand.

DELTA NO-VEIN COMPOUND retards sand grain expansion, practically eliminating the possibility of metal penetration.

Get the Facts...

Working samples and complete literature on Delta Foundry Products will be sent to you on request for test purposes in your own foundry.

DELTA OIL PRODUCTS CO.

MILWAUKEE 9, WISCONSIN

WHY DELAY THAT TRIAL ORDER?

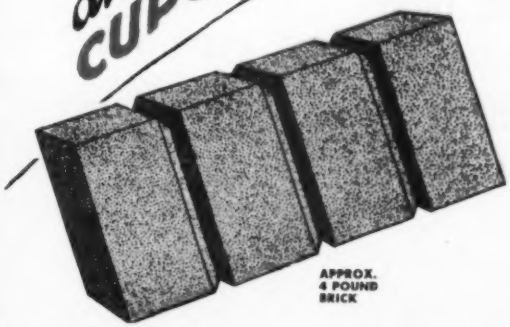
With "one stroke of the pen" you can obtain clean metal and better castings, and more efficient cupola operation. Or an order for Famous **CORNELL CUPOLA FLUX** *today.*

As a result of their first order, hundreds of leading foundries, including malleable foundries with cupolas, are on our list of regular customers and boosters of Famous Cornell Cupola Flux.

It removes the impurities that are detrimental to the production of the best castings, makes molten iron more fluid and reduces sulphur. And besides, machining is easier and smoother.

Cupolas are kept cleaner. Drops are cleaner, bridging over is practically eliminated and there is less erosion of brick or stone lining. This means less down time and maintenance cost.

PRE-MEASURED SCORED BRICK FORM takes but a few seconds to use. You simply lift it from container and toss it into the cupola with each ton charge of iron, or break off one to three briquettes (quarter sections) for smaller charges as per instructions.



Write for Bulletin No. 46-B

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Manufacturers of Iron, Semi-Steel, Malleable, Brass, Bronze, Aluminum and Ladle Fluxes – Since 1918

FAMOUS CORNELL FLUXES
Trade Mark Registered

BRASS FLUX

FAMOUS CORNELL BRASS FLUX cleanses molten brass even when the dirtiest brass turnings or sweepings are used. You pour clean, strong castings which withstand high pressure tests and take a beautiful finish. The use of this flux saves considerable tin and other metals, and keeps crucible and furnace linings cleaner, adds to lining life and reduces maintenance.

ALUMINUM FLUX

FAMOUS CORNELL ALUMINUM FLUX cleanses molten aluminum so that you pour clean, tough castings. No spongy or porous spots even when more scrap is used. Thinner yet stronger sections can be poured. Castings take a higher polish. Exclusive formula reduces obnoxious gases, improves working conditions. Dross contains no metal after this flux is used.

World Interest to

SPOTLIGHT...

A F S

INTERNATIONAL FOUNDRY CONGRESS AND SHOW

Whether you attend the A.F.S. International Foundry Congress and Show as a visitor, or whether your firm exhibits in the industry-wide Foundry Show, you can be sure of one thing . . . you will find the most influential elements of the foundry field gathered under one roof for a seven-day meeting that will attract the interest of the entire foundry world.

The appeal of this International Foundry Congress and Foundry Show stems from not one but, rather, the correct combination of events . . . technical sessions, round-table meetings, division luncheons and dinners, social events and hundreds of foundry product and service exhibits that will reflect the latest developments pertaining to modernization and economy of production in the foundry.

Technical sessions and exhibits complement each other—one tells the industry how the newest developments pertaining to cast metals are accomplished, the other shows industry equipment most adaptable for economy, efficiency and speed of operation in making these developments practical every-day applications.

Here is a combination, therefore, that benefits an industry—a "team" that keeps the products of that industry in a position to compete in today's market and to figure prominently in tomorrow's progress. Being a part of such a winning combine through participation in the A.F.S. International Foundry Congress and Show is your bid for progress and industry recognition.

"EVERY Foundry in '52" will BE THERE!

Atlantic City—May 1-7, 1952

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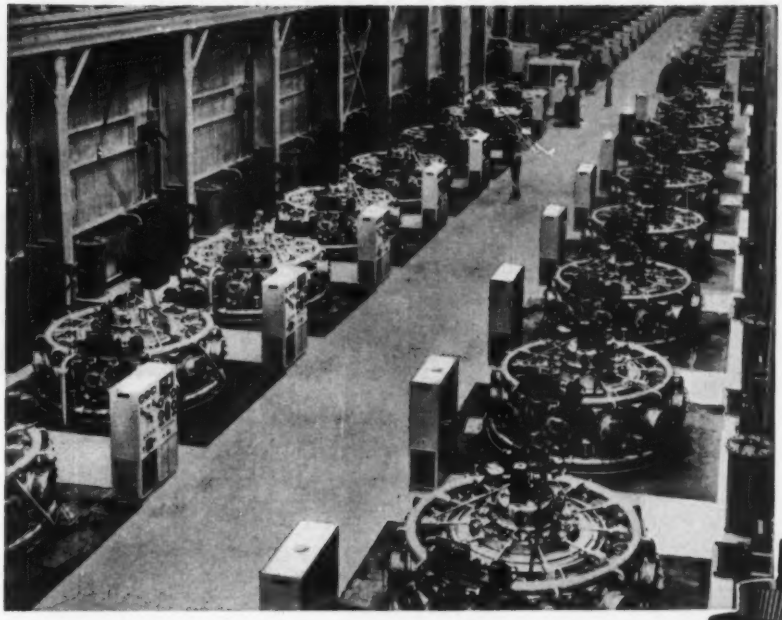
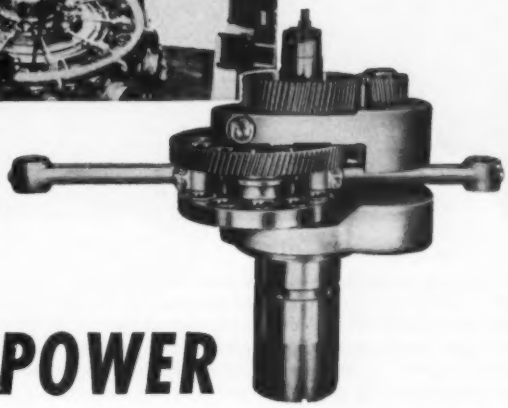




In world's largest internal combustion engine plant, operated by ALCOA, low cost power is essential for producing aluminum since every pound produced requires about 10 kilowatt hours of electrical power. *Right:* Nickel alloy cast iron crankshaft, weighing over 5,000 lbs., with gear train assembly, used in gas burning radial engine manufactured by Nordberg Mfg. Co., Milwaukee, Wisc.

200,000 HORSEPOWER

24 hours per day on NICKEL CAST IRON CRANKSHAFTS

Here are some of the 120 Nordberg radial engines with vertical crankshafts of nickel cast iron which provide low cost power at the Point Comfort Reduction Works of the Aluminum Company of America, Port Lavaca, Texas.

High strength nickel alloy iron is used not only for these crankshafts, but also for the cylinder blocks. In addition, many highly stressed parts of these 11-cylinder engines are made from heat treated nickel alloy steels.

Powered by natural gas from nearby fields, these Nordberg units demonstrate how nickel alloyed irons and steels help to cut bulk and deadweight, and to render further economies by minimizing wear and corrosion.

At the present time the National Production Authority limits the applications for which nickel and its alloys may be used. However, we shall continue to issue information on user experience with nickel-containing materials as we believe that dissemination of technical data and service experience can help to promote the intelligent utilization of critical materials, so essential in these times.

INCO

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N.Y.

DoALL FRICTION SAWING REDUCES FOUNDRY CLEANING ROOM COSTS THROUGH FASTER CUTTING AND CLOSER TRIMMING

● Cooper Alloy Foundry, Hillside, New Jersey, uses the 36" DoALL Zephyr high speed band machine at left, for *friction sawing* to remove gates and risers from stainless steel castings.

NOW — A NEW DoALL SAW BAND SPECIALLY DESIGNED FOR FRICTION SAWING AVAILABLE FROM LOCAL STOCK

BY using DoALL high speed band machines for *friction sawing* (heat concentration to soften the metal ahead of the saw band) many foundries have stepped up production as much as 10 times over other cutting methods, including flame cutting. The cut is made at speeds of 10,000 to 15,000 F.P.M. Even though these high speeds build up great frictional heat there is little or no danger of "skin hardening" or heat penetration into the wall of the work.

Best for shape cutting, the narrow DoALL Saw Band used lets the operator remove material easily from hard-to-get at spots. Secondary grinding operations are minimized because DoALL *friction sawing* leaves a finer finish. Cut all ferrous materials up to 1" thickness the DoALL *friction sawing* way. Ask for FREE DEMONSTRATION in your foundry. Call your local DoALL Sales-Service Store or write:

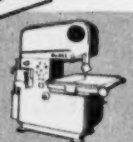
THE DoALL COMPANY • 254 N. Laurel Ave., Des Plaines, Illinois

NEW DoALL Friction Saw Bands have the teeth *locked in* by a special heat process giving you longer band life at lower cost. Increased production makes these bands readily available from local stocks. All are packaged in the exclusive DoALL "strip out" container for safety, convenience and band protection. There are DoALL Saw Bands for every job: precision filing, grinding, sawing, honing, polishing, friction sawing and cutting of all types of ferrous, non-ferrous metals and most all non-metallics.

WRITE FOR BULLETIN

BMF-2

DoALL



Machine Tools . . . Gaging Equipment . . . Tool Steel . . . Band Tools . . . Metal Working Supplies

MALLEABRASIVE®*

(SHOT AND GRIT)

SAVES $2995.00 a year CLEANING CASTINGS Like These!

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Lynchburg took advantage of Pangborn's offer to test Malleabrasive in their own shop. They tested it against ordinary shot for three months, and *their own records* prove Malleabrasive saves them $2995.00 a year on blast cleaning. Not only that, but replacement parts cost has been reduced *73.8%*—and abrasive handling has been cut in half!

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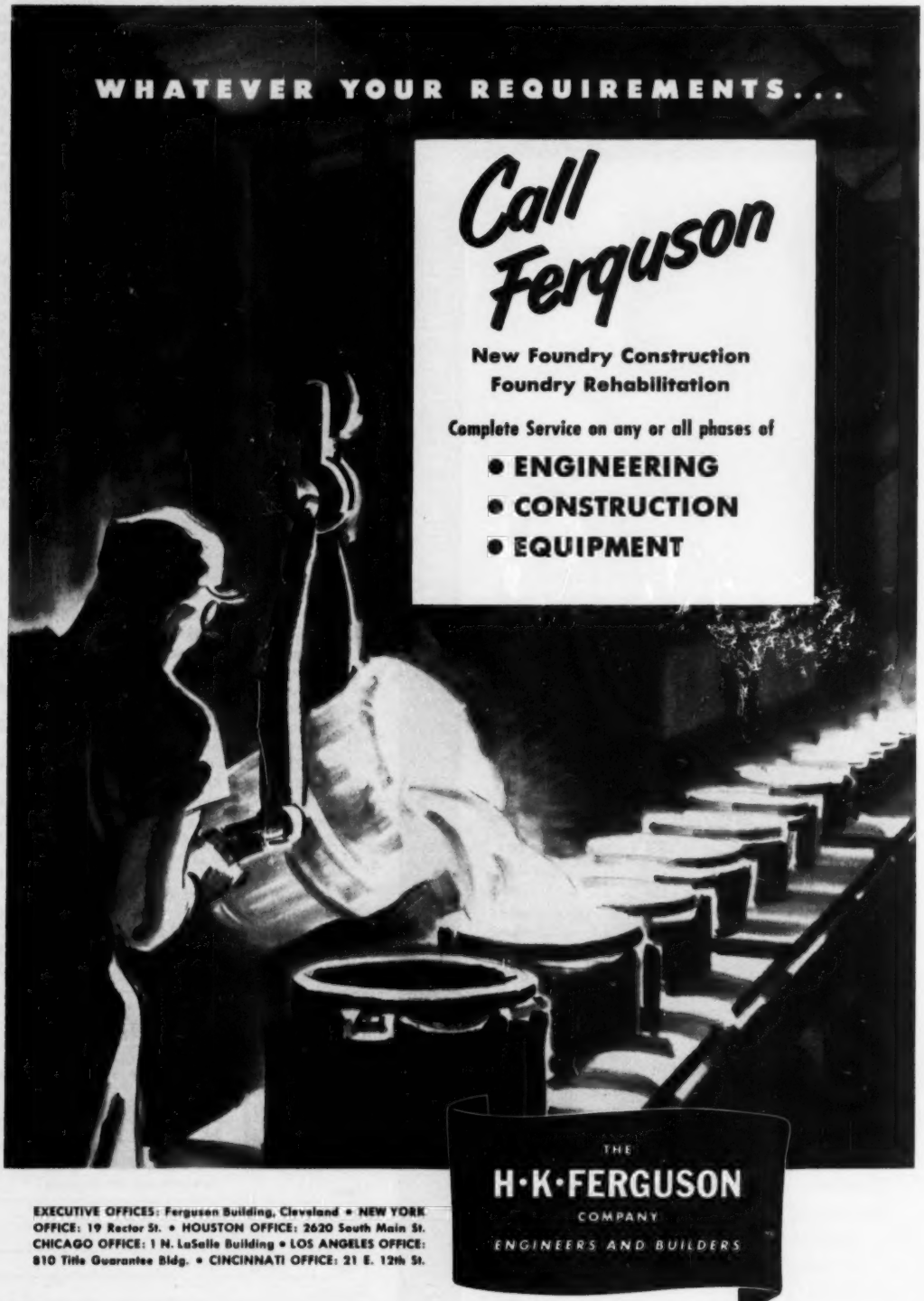

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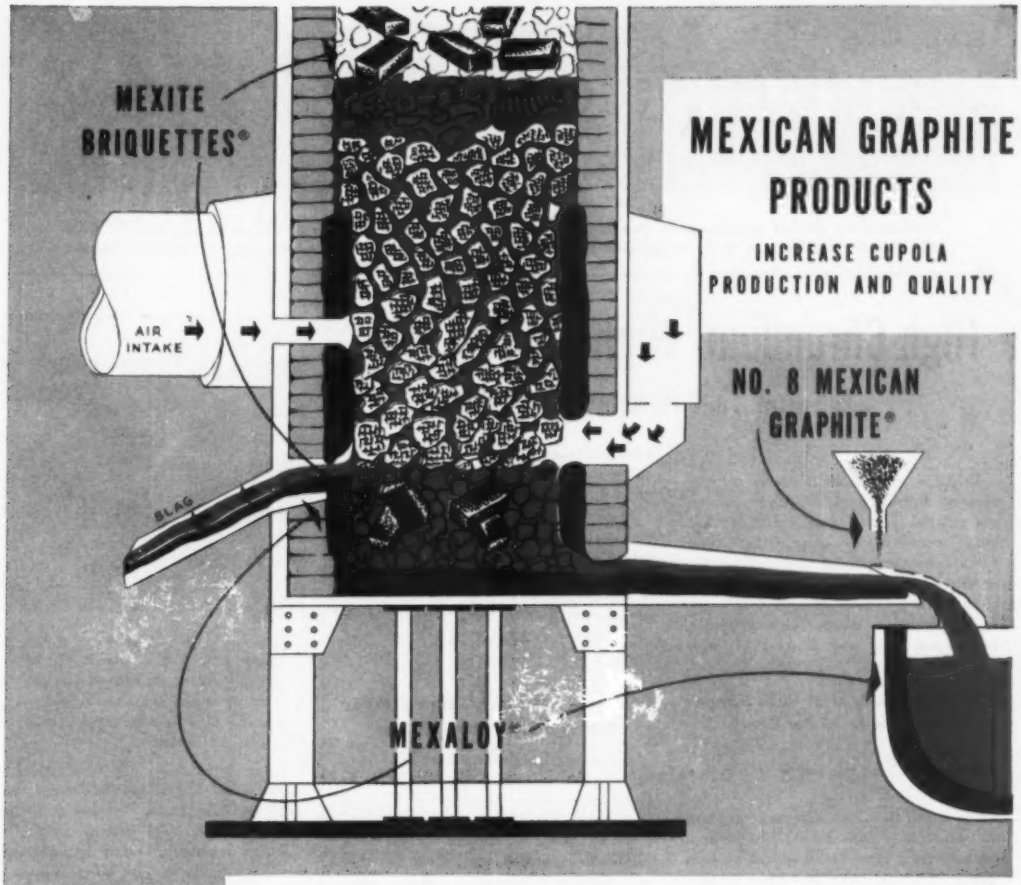

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No. 8 MEXICAN GRAPHITE is used for ladle additions to treat grey cast iron. Trickled into the cupola spout as metal falls into the ladle or with a direct ladle addition, it greatly reduces chill and hardness, *producing castings of increased machineability.* Normally only 2 lbs. of No. 8 need be added per ton of molten metal — a cost of only ten cents per ton — to assure castings which require no annealing. Write today for complete information on how Mexite Briquettes, Mexaloy, and No. 8 Mexican Graphite will give you better castings for less money.

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ELECTROMET Data Sheet

A Digest of the Production, Properties, and Uses of Steels and Other Metals

Published by Electro Metallurgical Company, a Division of Union Carbide and Carbon Corporation, 30 East 42nd Street, New York 17, N. Y. • In Canada: Electro Metallurgical Company of Canada, Limited, Welland, Ontario

High-Chromium, High-Carbon Iron

. . . the Iron That Hardens as it Wears

In many applications involving extreme abrasion, ordinary work-hardening alloys are not suitable. This is because most of these alloys require a definite pounding action for a martensite transformation, and the scouring action of an abrasive is not sufficient for development of high wear resistance. For this reason, high-chromium, high-carbon irons were developed – irons that wear-harden.

Chromium Content of Irons Ranges from 24 to 30 Per Cent

These irons are made in the electric furnace and have the following composition range:

Chromium	26 to 28 per cent
Carbon	2.60 to 2.80 per cent
Manganese	0.50 to 1.25 per cent
Silicon	0.25 to 0.75 per cent
Sulphur	max. 0.05 per cent
Phosphorus	max. 0.05 per cent
Nickel	minimum
Iron	balance

Irons of this composition are readily castable by steel casting techniques.

Development of Greater Wear Resistance by Heat Treatment

Structurally, these irons consist of primary iron-chromium carbides in a matrix of iron-chromium solid solution and secondary iron-chromium carbides. They are hard in the as-cast condition (500 to 550 Brinell), but when they are given an austenitization heat-treatment they develop much higher hardness (about 600 Brinell), and also have greatly improved wear resistance. Austenitization consists of heating these irons to a temperature of about 2012 deg. F. for an hour, then allowing them to cool in air. This heat-treatment promotes the formation of very unstable austenite—austenite that will transform to a harder martensitic end-product even under rubbing or mild impingement action. Austenitization has been found to be far more effective in increasing wear resistance than the promotion of unstable austenite by the addition of ferrite-forming alloying elements.

High-chromium, high-carbon irons can also be annealed to sufficiently low-hardness values for grinding or simple machining. Hardnesses as low as 350 to 450 Brinell can be obtained by heating the castings to temperatures of 1400 to 1450 deg. F. for 12 to 24 hours, then allowing them to cool in air.

Irons Have Wear Resistance Many Times That of Other Alloys

Austenitized high-chromium irons have been known to last as much as 21 times longer than other wear-resistant alloys in applications involving extreme frictional abrasion. These applications include sand-blast nozzles and liners, pantograph contact shoes, grinding disks, pulleys, chute-liner plates, dredge-pump liners, and rollers for crushing various hard materials.

In a recent test, high-chromium iron was compared to special wear-resistant steel castings as the material for hammers in a machine that was used to crush abrasive material. The chrome-iron hammers were found to have almost 7 times the wear resistance of the steel castings.

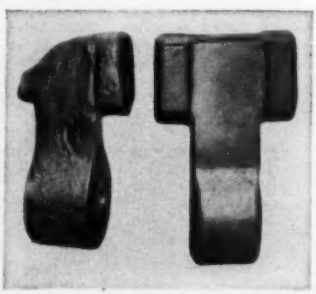

Fig. 1. After crushing the same amount of abrasive material in a hammer mill, the badly worn steel casting (left) had a weight loss of 37 per cent while the high-chromium iron casting (right) lost only 5.5 per cent.

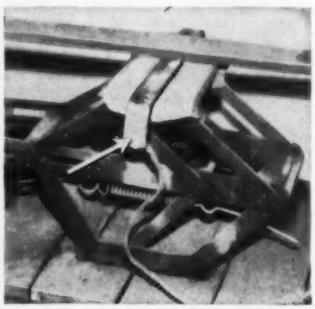

Fig. 2. This chrome-iron pantograph shoe had a service life of about 10 years. A tool steel that was used in similar service wore out in about 3 or 4 months; copper lasted about 24 hours.

When thoroughly backed up with zinc, the iron also has enough shock resistance to be used effectively as crushing hammers and jaw plates for many severe rock-handling jobs.

Metallurgical Service Available

For years, ELECTROMET high-carbon ferrochrome has been used to make chromium additions to abrasion-resistant high-chromium irons. If you should have any questions about either the production or use of these irons, write to the nearest ELECTROMET office. Our metallurgists will be glad to give many valuable suggestions and recommendations on how to make or use this iron most effectively.

Write for a free copy of the ELECTROMET publication, "Abrasion-Resistant High-Chromium Iron." This booklet is a collection of some of the best available information on how to make and to use abrasion-resistant iron castings most efficiently.

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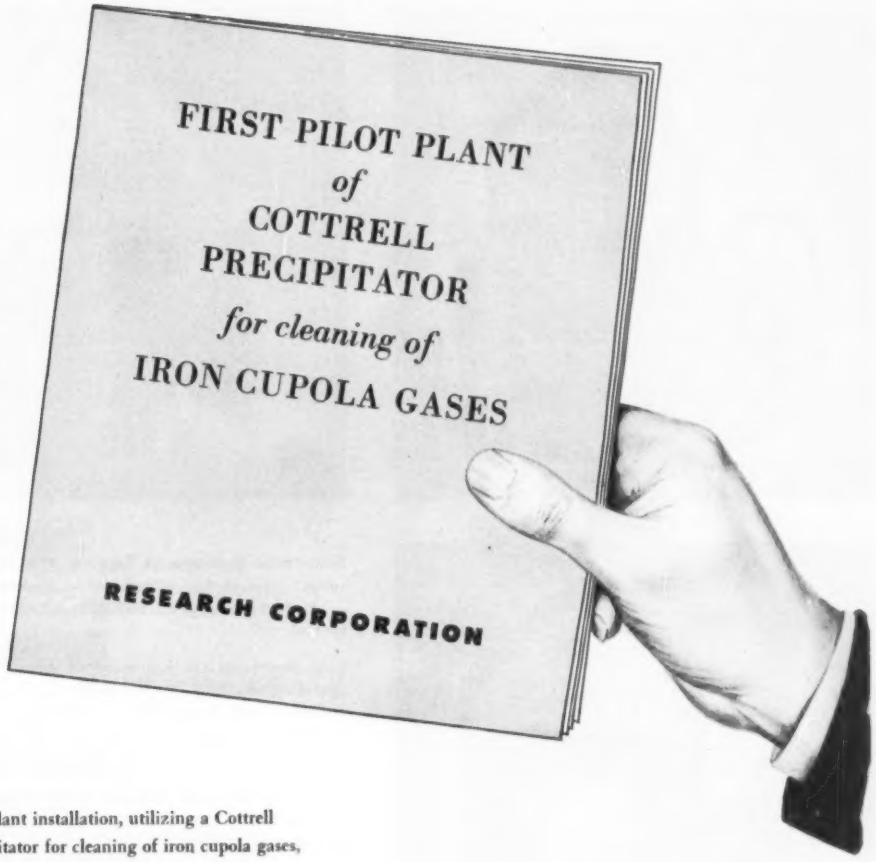
News on a New Process



The first pilot plant installation, utilizing a Cottrell Electrical Precipitator for cleaning of iron cupola gases, had resulted in detailed findings of industry-wide importance. On the basis of facts unearthed about cupola operation and the study of the design factors involved in this project, foundries have already placed orders for 15 precipitators with Research Corporation.

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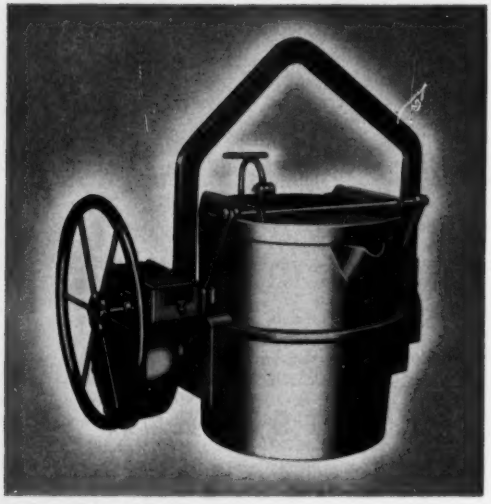

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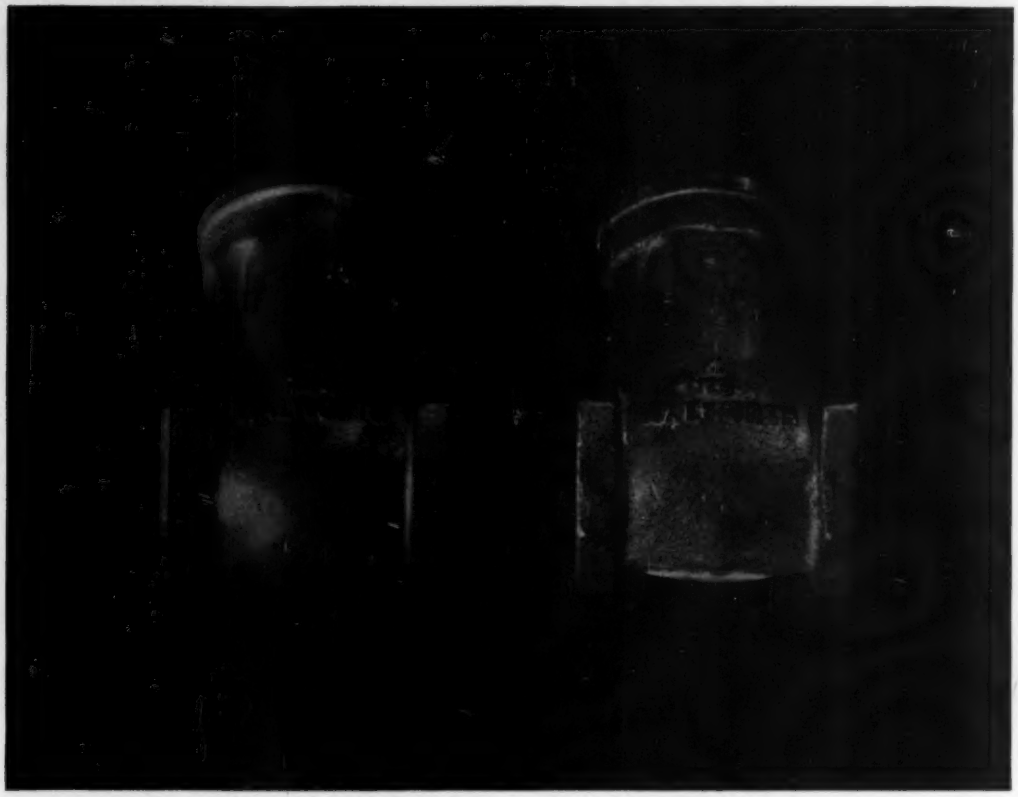

Valve castings by Walworth Company, South Boston, Mass. Casting at left is from a "C" Process shell mold. Note smooth surface compared with conventional casting at right.

COSTS SKID ON SMOOTH CASTINGS

Casting 2-inch valve bodies like the one above at left with thin-shell sand molds made by the Croning Process – saves Walworth Company at least 5 per cent in the amount of metal poured.

Bonded with BAKELITE Phenolic Resins, thin shell molds and cores for ferrous and non-ferrous casting bring other important savings compared with the use of conventional green sand molds. Almost pattern smooth castings, with tolerances as close as .003 to .004 inches per inch, cut down finishing time. And since the molds permit venting of gases more thoroughly during pouring, rejects are reduced to a minimum.

Other advantages:

- Molds and cores can be baked in 30 seconds to two minutes – in quantity with uniform quality.
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EVALUATE . . . THEN CONTROL

FOUNDRYMEN know less about sand than they would like to know—in some cases less than they think they know. As a result, sand, or misuse of sand, causes a high proportion of the defective castings produced.

Perhaps the basic reason for our sand difficulties is that we have been putting the cart before the horse in our sand testing and sand thinking. For 25 years we have been trying to make the behavior of sand in contact with liquid metal fit room temperature properties. This cannot be done. We cannot change the fundamental properties of a material by testing it.

The correct approach must be to determine these fundamental physical and chemical behaviors when the sand is in contact with liquid metal. This is evaluation. Then, and only then can room temperature properties be used—as controls.

This does not mean that present room temperature tests should be discarded. It is better to have a controlled unknown, than an uncontrolled unknown.

Evaluation tests for foundry sands or molding materials must involve contacting these materials with liquid metal. This calls for casting tests using simple castings, not production castings. It means making test castings of the simplest shapes over and over again, changing only one variable at a time.

Then, two supplementary tests must be made. These are the "why" tests, which tell why a particular sand behaves in a certain way under specific conditions, and the "time" tests, which show how sensitive sands are to variations in pouring time.

Only after these three evaluation tests have been made can the behavior of a molding material be discussed. Then, and only then, can the sand be controlled by room temperature or any other tests.

Several A.F.S. sand committees have led a quiet revolution in sand testing and sand thinking along these lines. This culminated in a meeting at the last A.F.S. Convention devoted exclusively to casting tests. Two committees, Elevated Temperature Properties of Iron Molding Materials and the Mold Surface Committee, have advanced tentative test castings.

Test castings have been used by the Mold Surface Committee for almost ten years. It is significant that work with these test castings, either by the committee or instigated by it has eliminated the mysteries about adhering sand—commonly called penetration. The mechanics and control of adhering sand, now well understood, are quite simple.

It is notable that when the problem of adhering sand is properly evaluated, only one of the four major variables, void size, is influenced by the sand itself. Is it any wonder that sand tests alone could not solve the problem of penetration? Now that the other variables have been evaluated, we know that adhering sand can be controlled by simple room temperature tests for void size and permeability.

JOHN B. CAINE, *Chairman Flowability Committee*
American Foundrymen's Society

John B. Caine, foundry consultant, Cincinnati, has for many years attacked sand and other problems vigorously and has reported his findings in many technical articles and talks. His many papers include the official A.F.S. exchange paper to the French Foundry Technical Association in 1948 and to the 1951 International Foundry Congress. After studying at the University of Cincinnati and Case Institute of Technology, he served a two-year apprenticeship at Interstate Foundries, Cleveland. In 1925, he was appointed metallurgist for Mathews Steel Casting Co., Cleveland, and in 1932 assumed the same duties for Sawbrook Steel Casting Co., Cincinnati, becoming research director. Since 1950 he has been a consultant.

metallurgy of SHELL MOLDING

Plastic bonded shell molds have an insulating quality overlooked by many foundrymen. This, and soundness, mechanical properties of shell cast metals, and other metallurgical factors studied at the New York Naval Shipyard are reported in this paper first presented at a 1951 A.F.S. Foundry Congress Shop Course.

B. N. Ames
S. B. Donner
N. A. Kahn
Metallurgy Branch, Material Laboratory
New York Naval Shipyard
Brooklyn, N. Y.

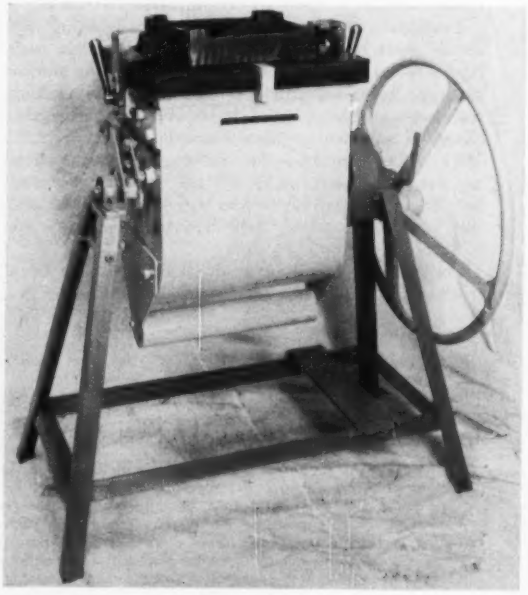
PREVIOUS ARTICLES* by the authors have discussed background and theory of shell molding. More recent work deals with some of the metallurgy of shell molding, principally of some of the non-ferrous alloys, although some data for gray iron and plain carbon steel are also presented.

The equipment used for making test specimen molds from which data for this report were obtained differed somewhat from the conventional. Major items consisted of the following:

(1) An experimental rollover machine, or dump box, illustrated in Fig. 1. This was basically a box of welded aluminum with a capacity of about 75 lb of sand-resin mixture. The box was mounted on frame-supported trunions, geared and counterweighted for hand-wheel rollover. An angle iron rim flange covered with ¾ in. thick strips of silicone-impregnated fiberglass laminate formed the protective face between the heated patterns and the box. A minimum drop of investment to the face of the pattern of 8 in. was provided to obtain a flocculation of the material which was considered beneficial.

(2) A set of cope and drag test bar pattern plates for aluminum alloys. The plates were of the 10 x 12 in. size originally employed on a rollover machine of earlier design, and had a fairly uniform section of ½ in. The pattern plates were cast in a heat-resistant, low-expansion alloy iron. Spring-return button-head ejection pins in conjunction with a mechanical stripping device provided uniform mold stripping. (An adaptor was used on the machine to accommodate these smaller plates.)

Fig. 1—Molding machine with adapter for 10 x 12 in. pattern plate. Box has capacity of about 75 lb sand.



* B. N. Ames, S. B. Donner, and N. A. Kahn, "Metal Parts with High Accuracy and Finish Produced by New Casting Process," *Materials and Methods*, August 1950, and "Plastic Bonded Shell Molds Used in New Casting Process," *Foundry*, August 1950.

NOTE: The assertions expressed in this paper are those of the authors and are not to be construed as official or necessarily reflecting the official views of the Navy Department.

(3) A set of wedge-plate patterns, shown in Fig. 2. The plates were also 10 x 12 in., adapted to the machine. These plates were fitted with stripping pins of the same type as the patterns described above and were of similar composition.

(4) A 14 x 18 in. double bronze test bar pattern plate. It was of similar composition to the smaller type, but of somewhat different construction. The reverse side was ribbed, and a uniform ¼ in. section was maintained throughout. Removable handles enabled the operator to work with heated plates without hand protection. Button-head stripping pins, spring-loaded for return, were also incorporated. Patterns and the attached runner system were of machined mild steel. The small pins surrounding the pattern provided recesses for holes in bolting and assembling mold halves, a procedure which negates fins and promotes casting

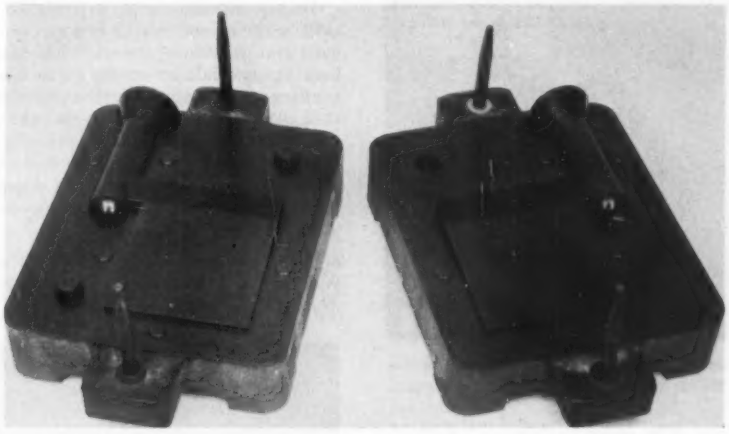


Fig. 2—Shows 10 x 12 in. wedge pattern plates cast in alloy iron.

to dimensional accuracy. Two types of replaceable tensile bar inserts were used for this pattern: a pair of bars of oversized gauge diameter (⅝ in.) requiring finishing to 0.505 in. diameter; and a pair calculated to cast to approximately 0.505 in. gauge diameter in order to determine as-cast properties.

(5) A wood pattern for green sand molding, duplicating the shell mold above. This was mounted on a followboard and incorporated two sets of replaceable tensile bars, as for the shell molding pattern.

(6) Miscellaneous mechanical rigging, including a portable muller-type mixer, mold stripping machines, shot loading tanks, mold bedding boxes, and rapid mold assembly devices. The majority of these items have been specifically designed for shell-mold production studies in the New York Naval Shipyard foundry.

All shell molds produced for metallurgical studies were made with an AFS 150 washed and dried sub-angular grain silica sand. In all instances the proportion of sand to resin was 91 to 9 by weight. The resin binder was a phenol-formaldehyde, with relatively low flow characteristics and high melting point. All metal patterns were heated to 400 F for the dwell. The dwell time was varied, depending on the thickness of mold desired. Molds were cured at 600 F for one minute, except where varying cure time studies were performed.

All shell molds were registered by means of the corresponding locating bosses and cavities on opposite halves, and were assembled by bolting. Molds were placed in a suitable container and backed with various materials as required for casting.

Insulating Effects of Shell Molds

It has been generally believed in connection with shell molding that the steel shot acts as a chilling agent, improving soundness and permitting better control of solidification patterns. Hence, the first experiments were designed to qualitatively evaluate the validity of this concept. Two shell molds of ¼ in. thickness were bolted, bedded in steel shot, and poured off in an 88-8-4 tin bronze at 2050 F, together with two standard dry sand test bar molds of the same design and dimensions. Tensile coupons were cut off, sectioned longitudinally, and macro-etched.

It was noted that the longitudinally etched section of the shell mold test bar did not indicate any greater degree of chill, even at X60 magnification, than the test bar poured in dry sand. These results clearly indicated that steel shot backing has no chilling action.

It was also observed that the etched, as-cast mold face of the shell molded bar developed a well defined grain pattern without any surface preparation, which is a good indication of the degree of surface finish obtainable. The as-cast section of the dry sand core did not develop a grain pattern upon etching, probably due to the surface roughness.

In order to investigate this more thoroughly, a number of shell wedge molds were made according to standard practice, except that ⅛ in. thick mold sections were used. Molds were bedded in each of the following materials: rammed Albany green sand, steel blasting grit, copper shot, and medium steel shot. A 2½ in. thickness of each bedding material was employed. Two wedges of similar design, size, and gating were molded in Albany green sand for comparison and control pur-

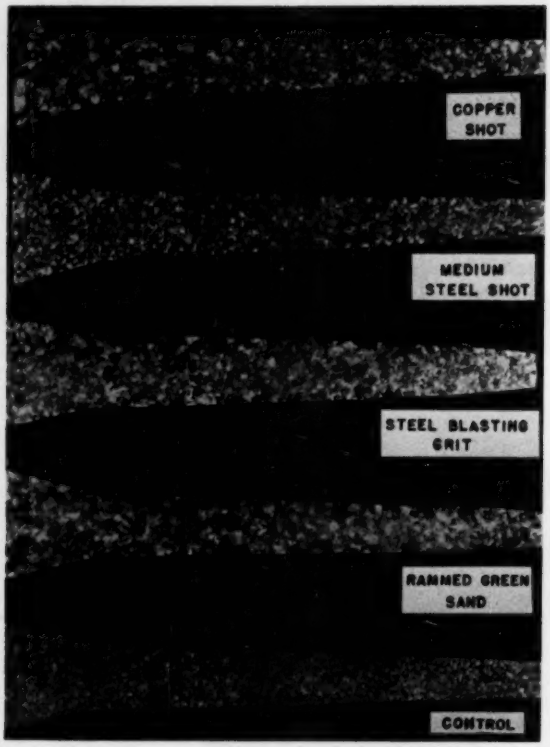


Fig. 3—Effect of varying back-up material on the macrostructure of shell-cast G bronze test plates is shown.

poses. The castings were poured at 2050 F in 88-8-4 alloy. Longitudinal sections were taken 2 in. from the end opposite the gates, polished, and etched for macro examination.

Figure 3 shows the effects of these various back-up materials on macrostructure, as compared with a slice taken from the conventional green sand control casting. The control casting developed a finer grain size pattern than any of the shell-cast sections, indicative of a more rapid rate of cooling upon solidification, or a greater insulating effect of shell molds. In addition, very little evidence of differential chilling between any of the backing materials used seemed to be present, despite large differences in thermal conductivity. This is another indication of the insulating effect of shell molds. Radiographs of a 1/8 in. thick slice adjacent to the macrostructures shown indicated a greater amount of skin effect on the green sand control. The green sand control slices, however, possessed a greater degree of internal unsoundness than any of the shell molds. In the shell molds, the specimens backed with steel and copper shot appeared to have a greater degree of internal soundness than the green sand and grit-backed specimens, probably due to the higher permeability of the shot in venting mold gases.

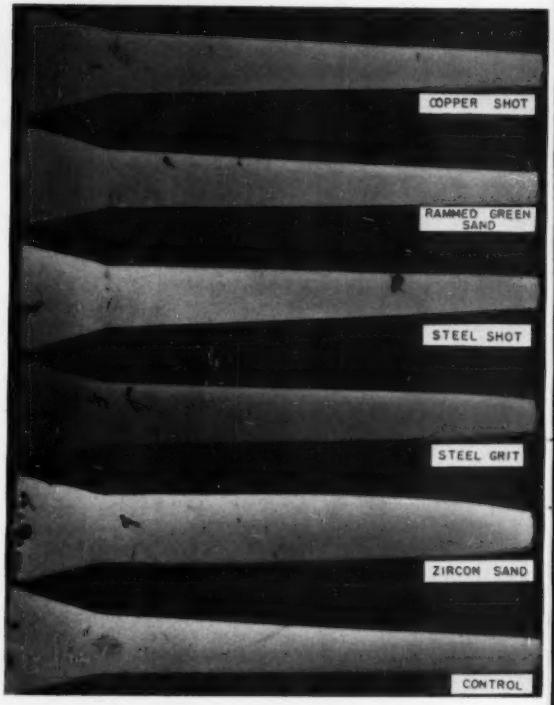
Further investigations of the effect of back-up material on macrostructure and soundness used different alloys as well as different back-up materials. Standardized 1/8 in. thick shell wedge molds were prepared in the usual manner. Two each were bedded in fine zircon sand, steel grit, medium steel shot, rammed green sand, and copper shot. The usual control wedges were also prepared. Four test series were run, one each in Navy class 2 aluminum alloy poured at 1250 F, 88-8-4 bronze at 2050 F, gray iron at 2750 F, and Navy class B steel at 2960 F. Thin slices (1/8 in.) were taken from all wedges 2 in. from the side opposite the gate for x-raying while the slices adjacent were polished and etched for macro-examination on the bronze and aluminum slices.

An inspection of the macro-etched aluminum slices showed no marked differences in degree of chill between the sand cast and shell cast wedge specimens. Thin-slice exographs indicated some slight porosity on all specimens, with little difference in soundness.

As before, the bronze macrostructure displayed a small, equiaxed grain pattern with a border of skin chill, while all shell cast specimens showed large equiaxed grains, without the skin chill effect. The lighter backing materials, zircon and green sand, allowed some swelling of the mold to yield oversized specimens. Thin slice exographs further illustrated the skin chill condition in the green sand control and indicated the greater degree of soundness in the shot-backed castings.

The gray iron shell-cast slices displayed no significant differences on x-ray examination insofar as gas

Fig. 4—Exographs showing effect of varying back-up materials on shell-cast class B steel test plates. Shrinkage defects due to design of the gate were expected.



porosity was concerned. Slight shrinkage was present on the zircon and steel shot-backed specimens. As in the G bronze series, the zircon and green sand-backed specimens showed swelling indicative of mold deflection. The control exhibited some surface roughness due to the gating technique employed.

A reversal in the general soundness trend of the three alloys was apparent from the examination of the class B steel thin-slice exographs (Fig. 4.) The control showed less unsoundness due to gas than any of the shell-cast specimens, although some expected shrinkage due to gating design was present in all. Little difference was noted in the shell-cast series. Here again, the zircon-backed shell deflected to produce an oversize specimen.

Effect of Shell Thickness

Plate molds were made following standard preparation practice except that dwell times were varied to produce molds of uniform section in the following thicknesses: $\frac{1}{16}$, $\frac{1}{8}$, $\frac{1}{4}$, and $\frac{5}{16}$ in. Two of each thickness were clamped and bedded in steel shot, with $2\frac{1}{2}$ in. backing all around, together with two green sand control plates. These were cast in class 2 aluminum alloy at 1250 F, with duplicated heats in G bronze at 2050 F, gray iron at 2720 F, and Navy class B steel at 2950 F. As in the back-up test series, $\frac{1}{8}$ in. slices were taken longitudinally from the wedges 2 in. from the side opposite the gate for x-ray inspection, while adjacent slices were macro-etched on the G bronze and aluminum alloy specimens.

No appreciable variations in soundness were found, confirming the earlier test results, although the mean grain size of the sand-cast control was slightly smaller. The bronze specimens did not display any appreciable sensitivity to shell thickness from the standpoint of internal soundness. The macros showed the skin chill condition on the green sand control, and the usual lack of skin chill with larger grain size in the shell mold castings. The trend toward smaller grain size with a thinner shell is indicative again of the insulating effect of shell molds, as is shown in Fig. 5.

The shell-cast gray iron slices exhibited light shrinkage at the sinkhead-wedge junction, with a slightly heavier shrinkage condition on the $\frac{1}{8}$ and $\frac{1}{16}$ in. shell slices than on the two heavier shell specimens. The controls showed least shrinkage, possibly due to a slight gas porosity condition, but had rougher surfaces.

Overall x-ray radiography on the whole steel plates demonstrated that the green sand controls were inferior from the standpoint of surface finish, although all castings possessed a certain amount of shrinkage due to gating design. The thin slices showed the shrinkage to be less extensive in the $\frac{5}{16}$ in. slice, with little difference in gas porosity.

Influence of Mold Curing Time

The effect of this variable on the macrostructure and internal soundness was also investigated with respect to gas porosity of wedge plates cast in 88-8-4 bronze. A number of plate molds were made following standard procedures, except that curing time at 600 F was varied from $\frac{1}{2}$ minute to $2\frac{1}{2}$ minutes, in $\frac{1}{2}$ minute increments. Two molds in each cure time group were clamped, bedded in $2\frac{1}{2}$ in. of steel shot, and poured in G bronze at 2050 F, together with two green sand

Fig. 5—Effect of varying shell thickness on the macrostructure of shell-cast G bronze test plates. Note the trend toward smaller grain size with a thinner shell.

control plates. The castings were sectioned in the usual manner, a $\frac{1}{8}$ in. slice being taken 2 in. from the end opposite the ingate, with the adjoining slice etched for macroexamination.

No significant trends were found in the macrostructure of the shell-cast plates. The thin slice x-rays showed a similar lack of appreciable difference in soundness, despite the variation in cure time.

Effect of Varying Sand Base

To determine the effect of a substitute sand grain such as zircon sand (a considerably denser material of higher heat conductivity), a number of $\frac{1}{4}$ in. shell wedge plate molds were prepared. One set contained a normal silica sand mix; the other substituted a fine (about 140 AFS) zircon sand, in the proper proportion (4.5 per cent by weight) to maintain the normal sand to resin volume relationship. Eight molds of each type were clamped and bedded in steel shot, $2\frac{1}{2}$ in. all around, together with eight green sand control plate molds. Two of each were cast in class 2 aluminum alloy at 1250 F, 88-8-4 bronze at 2050 F, gray iron at 2740 F, and Navy class B steel at 2950 F, as in previous studies. Macro and thin-slice x-ray specimens were taken in the usual way.

The photomacrograph of the aluminum slices (Fig. 6) showed finer grain size in the zircon-cast specimen, indicative of a more rapid rate of solidification. Positive prints of thin-slice exographs showed equivalent microporosity in green sand and silica-shell cast slices,

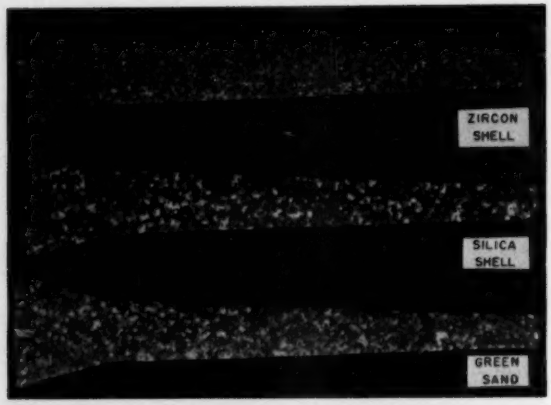


Fig. 6—Effect of varying base sand on the macrostructure of the shell-cast 43 aluminum alloy test plates.

with somewhat less microporosity in the zircon specimen. Over-all x-ray radiography on the plates further illustrated this condition.

In the bronze plates, somewhat finer grain was evidenced by the zircon-cast specimen than by the silica sand shell.

Exographs of the gray iron specimens showed an area of shrinkage at the sinkhead-plate junction of the sand-cast plate, with less shrinkage in the silica shell specimen and practically none in the zircon shell slice.

The exographs of class B steel slices cast in silica and zircon shell molds did not exhibit any appreciable differences.

Pouring Temperature vs. Mechanical Properties

Duplicate heats were run to determine the optimum pouring temperature for shell-cast class 2 aluminum alloy tensile bars, and to secure comparisons of elongations and ultimate strengths between shell-cast and green sand bars at varying pour temperatures. For these heats, the as-cast 0.505 in. double tensile bar design was used, the plastic bonded shells being molded with a 10 x 12 in. plate and pattern, and the green sand counterparts being made in 0 Albany sand with a wood pattern of similar design and dimensions. On each heat, two shell molds and two green sand molded tensile coupons each were poured at 1350, 1300, 1250, and 1200 F. In addition, two shell-mold wedge plates and two green sand wedge plates were poured at each temperature. All shell molds were bedded with 2 in. of steel shot.

The tensile bars were cut off and pulled in tension; ⅛ in. slices were taken from the wedge plates in the usual area and x-rayed. Curves of pouring temperature vs. mechanical properties of each type of tensile bar casting were made (Fig. 7), representing a composite of both bars. It was observed that at the higher and optimum pouring temperatures, the properties were slightly superior for the shell-cast bars. Thin-slice x-rays on both heats showed a tendency for greater soundness in the shell-cast specimens. It was deduced that the superior properties of shell-cast bars at the temperatures noted is due to the much cleaner cold fracture.

For similarly testing the tin-bronze tensile bars, the pattern equipment used was a double bottom-gated test coupon pattern mounted on a 14 x 18 in. plate for shell molding and a wood counterpart mounted on a follow-board for green sand molding. Two types of tensile bar inserts were used for each pattern, one a pair of bars of standard oversize gage diameter requiring machining to finish to 0.505 in. gage diameter, and the second a pair calculated to cast to about 0.505 in. gage diameter. The purpose of this latter set was to secure additional data relative to the skin chill effect, or lack of skin chill, on comparative mechanical properties of shell-cast bars.

Four Navy M bronze heats were run on this series,

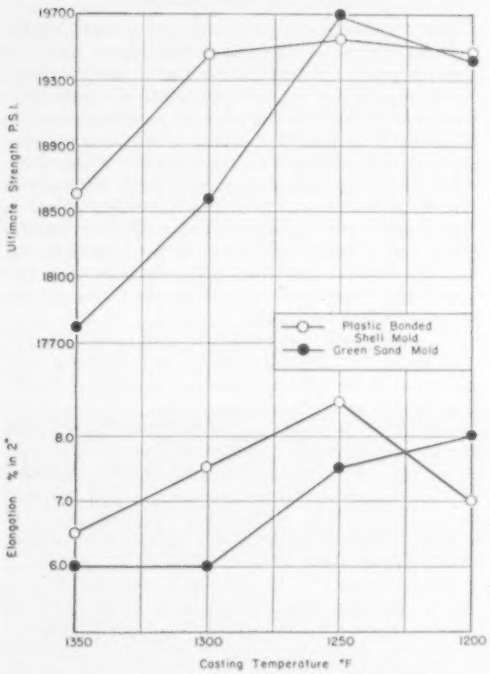
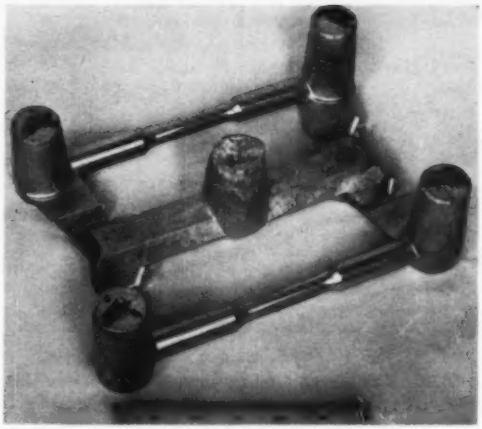


Fig. 7—Properties vs. Pour Temperature for 43 aluminum alloy shell cast and green sand cast tensile bars.

consisting of two duplicate heats for each type of tensile bar insert used. On each heat, shell molds bedded in steel shot and five green sand molded counterparts were cast, one of each for each of the following temperatures: 2150, 2100, 2050, 2000, and 1950 F. Following knockout and inspection, the tensile coupons were cut off, measured in gage or machined to gage size as required, and pulled in tension.

A study of the average yield strength, ultimate strength, and elongation curves for the duplicate heats in which the as-cast 0.505 in. tension bar inserts were used (Fig. 8) showed higher ultimates and elongations at virtually all pouring temperatures for the shell-cast specimens, but lower yield strengths. On the machined bar series the averaged values followed the same pat-



Shows as-cast 43 aluminum alloy test bars, shell molded.

tern, with higher ultimates and elongations and lower yield strengths throughout the range.

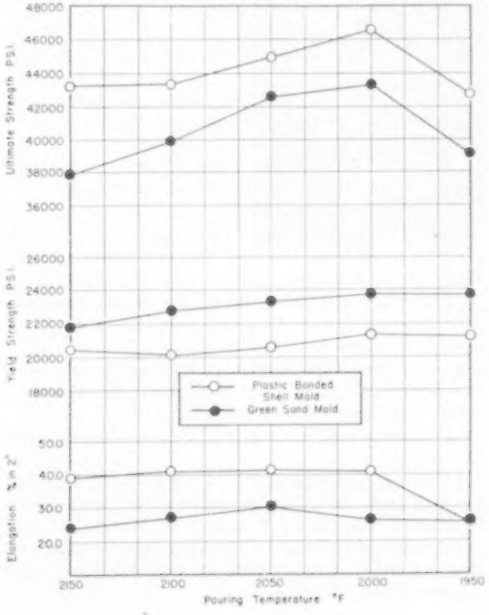
Bottom gating was used on both the shell-cast and the green sand test bars. While this is not expected to yield the best properties for the design of test bar employed, it was used because shell molds require this type of gating. Although the ultimate in properties was probably not attained, the gating system did afford a direct comparison between shell-cast bars and the green sand test bars.

The green sand test specimens exhibited a greater amount of dross and gas porosity than the shell-cast specimens. This was due in great part to the only variable, the molding material (green sand), and no doubt influenced the ultimate strength and ductility. The apparent anomaly—shell-cast bar yield strengths were lower than those of the green sand cast bars while the other properties were higher—may be due to the slower cooling and lack of skin chill of the shell mold castings.

Generally, indications are that shell molded castings in the non-ferrous alloys and gray iron fields can develop mechanical properties and internal soundness at least equal to, if not superior to, green sand castings. The trend toward greater internal soundness and higher mechanical properties can be attributed to cleaner metal with less gas inclusions and dross. In the medium carbon steel alloys, it is believed that additional development work is required on molding mixtures before this class of alloy becomes commercial for shell molding.

The authors wish to express their appreciation to Mr. E. Chrzan of the Material Laboratory staff for his assistance in securing the data contained in this paper.

Fig. 8—Properties vs. Pour Temperature for Navy M bronze, as-cast, shell and green sand cast tensile bars.



Plan Safety, Hygiene Conference At U. of Michigan for Next April

H. E. Miller, School of Public Health, University of Michigan, reports that a committee is planning a two-day conference on safety and hygiene in foundry practice. Committee membership includes representatives of the foundry industry and public health officials. Tentatively scheduled for early in April, the conference will emphasize talks with demonstrations in the university foundry, or movies.

As planned, the first day will be composed of general sessions for all foundrymen, while the second day's activities will be divided into ferrous and non-ferrous groups.

General sessions will include control and prevention of dust, subdivided into housekeeping, methods (dry sweeping, wet sweeping, and vacuum cleaning), isolation (separate core room, for example), substitution (shot blast for sand blast, non-siliceous parting compounds, etc), and wetting agents. Under general control will come respirators (selection, proper use, operator education, and maintenance) and ventilation, both local and general.

Ferrous program on the second day will be divided into two main topics, jobbing and production. Areas of discussion to be used for both topics cover melting, molding, core making, pouring, shake-out, cleaning, grinding, and waste removal. Each area will be developed from the standpoints of sources of dust and fumes, extent and scope of condition, and methods for removal or control.

Non-ferrous program will cover the nature, manifestation, and management of lead poisoning; the measurement and evaluation of exposure by mechanical means; and control phases of melting, pouring, and cleaning.

Concluding conference, Kenneth M. Morse, director of Safety & Hygiene and Air Pollution, A.F.S., will detail the A.F.S. ten-year program for industrial health to both ferrous and non-ferrous groups.

Name Committees for

1952 A.F.S. INTERNATIONAL

FOUNDRY CONGRESS & SHOW

ANTICIPATED as one of the greatest meetings of foundrymen in the history of the metal castings industry, the 1952 A.F.S. International Foundry Congress & Show will draw foundrymen from all over the free world to Atlantic City, May 1 through 7, to hear the latest in foundry technology and to view the newest tools of the industry.

Key International Foundry Congress committees will be made up of top officials of United States and technical and trade organizations abroad which cooperate with A.F.S.

NCC President Heads General Committee

Headed by C. V. Nass, Beardsley & Piper Division, Pettibone Mulliken Corp., Chicago, president of the National Castings Council, the General Convention Committee will include A.F.S. National President Walter L. Seelbach, Vice-President I. R. Wagner, Secretary-Treasurer Wm. W. Maloney, and official A.F.S. representatives in Europe, Australia, Scandanavia and South and Central America. Also named to the General Committee are representatives of all member organizations in the National Castings Council; and honorary representatives from England and the United States.

Ladies Entertainment for the 1952 International will be in charge of a committee made up of ladies who have served as chairmen of the Ladies Entertainment Committees at the last ten A.F.S. Conventions. Wives of all past A.F.S. Presidents will be designated Honorary Hostesses of the Ladies Committee.

The receiving line at the A.F.S. International Reception for overseas visitors on Sunday, May 4, will be headed by Guido Vanzetti, president of the International Committee of Foundry Technical Associations, A.F.S. President Seelbach, Vice-President Wagner and the A.F.S. Vice-President Elect, and will include the presidents of any international foundry groups in attendance or official delegates from these groups, and presidents of organizations member to the National Castings Council.

Chairmen and vice-chairmen of the 40 Chapters of the American Foundrymen's Society will be asked to serve as members of a general Congress Reception Committee. They are:

Birmingham District: Chairman C. K. Donoho, American Cast Iron Pipe Co., and Vice-Chairman Fred K. Brown, Adams, Rowe & Norman, Inc.

British Columbia: Chairman W. M. Armstrong, University of British Columbia, and Vice-Chairman Herbert Heaton, Leston & Burpee, Ltd.

Canton District: Chairman C. B. Williams, Massillon Steel Castings Co., and Vice-Chairman Alexander Prentice, Stark Foundry Co.

Central Illinois: Chairman R. E. Dickison, Brass Foundry Co., and Vice-Chairman George Rockwell, Caterpillar Tractor Co.

Central Indiana: Chairman Robert Spurgin, III, Swayne Robinson Co., and Vice-Chairman C. O. Schopp, Link-Belt Co.

Central Michigan: Chairman Thos. T. Lloyd, Albion Malleable Iron Co., and Vice-Chairman Austen J. Smith, Michigan State College.

Central New York: Chairman Wm. D. Dunn, Oberdorfer Foundries, and Vice-Chairman D. J. Merwin, Oriskany Malleable Iron Co.

Central Ohio: Chairman Wm. T. Bland, Commercial Steel Castings Co., and Vice-Chairman E. M. Durstine, Keener Sand & Clay Co.

Chesapeake: Chairman A. S. Kittrell, Leach Pattern Shop, and Vice-Chairman C. D. Galloway, Chambersburg Engineering Co.

Chicago: Chairman W. W. Moore, Burnside Steel Foundry Co., and Vice-Chairman John H. Owen, Harbison Walker Refractories Co.

Cincinnati District: Chairman A. W. Schneble, Jr., Advance Foundry Co., and Vice-Chairman Burt A. Genthe, S. Obermayer Co.

Detroit: Chairman Vaughan C. Reid, City Pattern Foundry & Machine Co., and Vice Chairman Michael Warchol, Atlas Foundry Co.

Eastern Canada: Chairman W. Turney Shute, Canadian Car & Foundry Co., and Vice-Chairman A. J. Moore, Montreal Bronze, Ltd.

Eastern New York: Chairman John E. Waugh, General Electric Co., and Vice-Chairman L. M. Townley, Adirondack Foundries & Steel, Inc.

Metropolitan: Chairman J. S. Vanick, International Nickel Co.

Mexico City: Chairman N. S. Covacevich, La Consolidada, S. A., and Vice-Chairman Juan Latapi Sarré, Fundiciones De Hierro Y Acerro, S. A.

Michiana: Chairman S. F. Krzeszewski, American Wheelabrator & Equipment Corp., and Vice-Chairman Andrew Peterson, Oliver Corp.

Mo-Kan: Chairman E. C. Austin, Jr., National Aluminum & Brass Foundry, and Vice-Chairman John F. Redman, Jr., Redman Pattern Works.

Northeastern Ohio: President G. J. Nock, Nock Fire Brick Co., and Vice-President F. C. Cech, Cleveland Trade School.

Northern California: President Philip C. Rodger, General Metals Corp., and Vice-President G. W. Stewart, East Bay Brass Foundry.

Northern Illinois-Southern Wisconsin: Chairman Carl L. Dahlquist, Greenlee Bros., and Vice-Chairman Jack Rundquist, Beloit Casting Co.

Northwestern Pennsylvania: Chairman J. D. James, Cooper-Bessemer Corp., and Vice-Chairman Fred J. S. Carlson, Weil-McLain Co.

Ontario: Chairman R. H. Williams, Canadian Westinghouse Co. Ltd., and Vice-Chairman Andrew Reyburn, Cockshutt Plow Co. Ltd.

Oregon: Chairman E. J. Hyche, Rich Mfg. Co., and Vice-Chairman W. M. Halverson, Electric Steel Foundry Co.

Philadelphia: Chairman George Bradshaw, U. S. Naval Base, and Vice-Chairman Arnold N. Kraft, Wilkening Mfg. Co.

Quad City: Chairman W. C. Bell, Frank Foundries Corp., and Vice-Chairman Boyd L. Hays, Union Malleable Iron Works.

Rochester: Chairman Charles E. Vaughn, Ritter Co., Inc., and Vice-Chairman Leon C. Kimpal, Rochester Gas & Electric Corp.

Saginaw Valley: Chairman A. E. Edwards, Chevrolet Grey Iron Foundry, GMC, and Vice-Chairman K. H. Priestley, Vassar Electroloy Products, Inc.

A.F.S. President

Walter L. Seelbach of Cleveland as National President of the Society will be host to free world foundrymen at the 1952 A.F.S. International Foundry Congress & Show in Atlantic City May 1 through 7. A veteran of 41 years in the foundry industry, Mr. Seelbach heads his own Superior Foundry, Inc., Cleveland.

St. Louis District: Chairman Ralph M. Hill, East St. Louis Castings Co., and Vice-Chairman H. W. Meyer, General Steel Castings Corp.

Southern California: Chairman H. W. Howell, Howell Foundry Co., and Vice-Chairman H. G. Pagenkopp, Angelus Pattern Works.

Tennessee: Chairman Porter Warner Jr., Porter Warner Industries, and Vice-Chairman W. M. Hamilton, Crane Co.

Texas: Chairman John M. Bird, American Brass Foundry, and Vice-Chairman P. B. Croom, Houston Pattern Works.

Timberline: Chairman C. C. Drake, Griffin Wheel Co., and Vice-Chairman J. E. Schmuck, Rotary Steel Casting Co.

Toledo: Chairman J. A. Mescher, Unitcast Corp., and Vice-Chairman J. G. Blake, Alloy Founders.

Tri-State: Chairman Dan A. Mitchell, Progressive Brass Manufacturing Co., and Vice-Chairman C. C. Beagle, Webb Corporation.

Twin City: G. Fred Quest, J. F. Quest Foundry Co., and Vice-Chairman J. W. Costello, American Hoist & Derrick Co.

Washington: Chairman James D. Tracy, Salmon Bay Foundry Co., and Vice-Chairman W. L. Mackey, Washington Stove Works.

Western Michigan: Chairman R. P. Shaffer, Lakey Foundry & Machine Co., and Vice-Chairman W. J. Cannon, Nugent Sand Co.

Western New York: Chairman Erwin Deutschlander, Worthington Pump & Mach. Corp., and Vice-Chairman Carl A. Harmon, Hanna Furnace Corp.

Wisconsin: President George E. Tisdale, Zenith Foundry Co., and Vice-President J. G. Risney, Risney Foundry Equipment Co.

Since Atlantic City, site of the 1952 International, lies almost equidistant between three Chapters, Chesapeake, Metropolitan and Philadelphia, the chairmen of those Chapters will be seated at the speakers' table during the Annual Banquet of the Society, to be held the evening of May 3.

Show Space 85 Per Cent Sold

Sharing the world foundry spotlight at the 1952 International will be the week-long technical program and the concurrent Foundry Show. Expected to bring together a tremendous number and variety of foundry equipment, supplies and services, the 1952 Show will be housed on a single floor of the Atlantic City Auditorium, largest in the world. More than 85 per cent of the available Show space has already been sold.

In addition to its unexcelled exhibit facilities, Atlantic City offers a wide choice of luxury hotels with thousands of comfortable rooms and suites and excellent luncheon and dinner accommodations.

The Foundry Show will remain open throughout the entire Congress, paralleling the six-day technical program, which will be closely scheduled by divisional interests so as to give visitors maximum opportunity to attend those sessions of particular interest to them within the shortest possible time.

In this way, non-ferrous technical sessions, shop courses, round table luncheons and related events

General Chairman

C. V. Nass, Vice-President, Beardsley & Piper Division, Pettibone Mulliken Corp., Chicago, is president of the National Castings Council and of the Foundry Equipment Manufacturers Association. Mr. Nass is a past chairman of the Society's Chicago Chapter.

Hoyt Lecturer

John S. Bugas, Vice-President Industrial Relations, Ford Motor Co., has had a colorful career as a lawyer and as a special agent for the FBI. Since 1944 he has been actively engaged in virtually every phase of industrial relations work with Ford and is a tireless worker in several civic organizations.

are scheduled for the first three days of the Congress, while ferrous sessions and activities will be largely confined to the last three days. General interest sessions are also primarily scheduled for the last three days of the Congress.

Top Congress events will include a colorful opening day ceremony, the A.F.S. Chapter Officers and Directors Dinner, Annual A.F.S. Business Meeting, Charles Edgar Hoyt Annual Lecture, Annual A.F.S. Banquet, International Reception and International Educational Dinner.

Chosen to give this year's Charles Edgar Hoyt Annual Lecture, top technical address of the 1952 International Foundry Congress presented immediately following the Society's Annual Business Meeting, May 3, is John S. Bugas, Vice-President Industrial Relations, Ford Motor Co., Dearborn, Mich.

Highlight social event of the foundry year and the 1952 International Foundry Congress is the Annual Banquet of the American Foundrymen's Society the evening of May 3. This year for the first time the banquet will feature professional entertainment instead of a speaker.

Two Defense Luncheons Scheduled

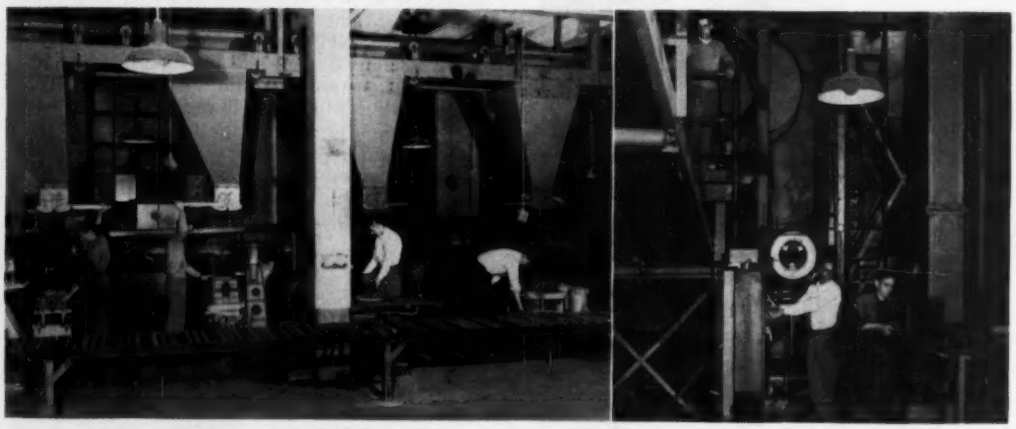
Two luncheon meetings which proved extremely popular last year, the Defense Production Luncheon Meeting and the Equipment & Supplies Luncheon, will again be held. The Defense Production Luncheon, which affords foundrymen an opportunity to discuss their problems with top National Production Authority officials, will be divided into two luncheons, one for non-ferrous foundrymen on May 1, and one for ferrous foundrymen May 5.

In addition to the six days of regular technical sessions, Non-Ferrous, Gray Iron, and both Ferrous and Non-Ferrous Sand Shop Courses are scheduled, as are Aluminum & Magnesium, Brass & Bronze, Patternmaking, Malleable, Gray Iron and Steel Round Table Luncheons. International Committees and A.F.S. Divisional and General Interest Committees will meet throughout the Congress, particularly on Sunday, May 4, when no technical meetings are scheduled.

Exhibits of foundry equipment, supplies and services in the concurrent Foundry Show will be open at slightly varying hours throughout the Congress so as to provide maximum opportunity for their inspection.

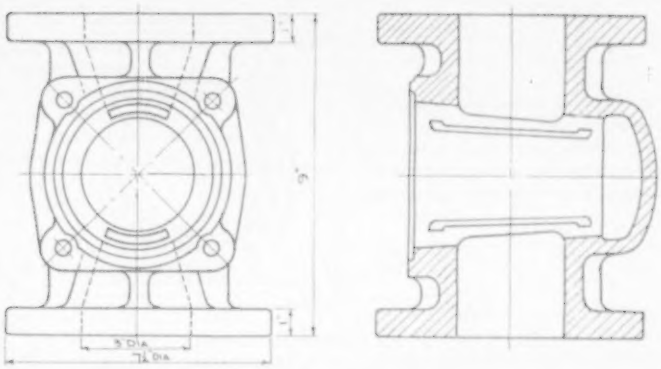
The combination of a week-long technical program that offers the latest information on every phase of the metal castings industry, and the world's greatest concentration of new tools for the foundry industry is expected to make the 1952 International Foundry Congress & Show a "must" for technicians and operating men from "Every Foundry in '52."

OHIO STATE UNIVERSITY INSTALLS MODERN SAND DISTRIBUTION SYSTEM



Newly installed at Ohio State University is a modern sand preparation and distribution system valued at $70,000 and contributed by some 20 industrial firms in five states. Installed in the school foundry in the Industrial Engineering Building, the new sand handling system is used in conjunction with seven new molding machines, four of which are shown in photograph at left. In background are both levels of a mold conveyor, with mold lift at extreme right. Photograph at right shows a student operating the control panel while another student removes the flask from the shakeout. Also in photo are a centrifugal bucket elevator, sand storage hopper, mixing platform and part of the sand distribution belt.

Fig. 1—Sketch of flanged plug valve body casting prior to planning a gating and risering system for it.



In this article, a prize-winning paper in Eastern Canada Chapter's 1951 Technical Papers Contest, the author tells how side risering of special alloy iron cut cleaning room costs and produced sound castings when top risering failed. Cleaning room costs, according to the author, can make the difference between profit and loss in a small shop operating on close margins.

SIDE RISERS CUT CLEANING ROOM COSTS ON ALLOY IRON CASTINGS

Roy Chamberlin
Dominion Engineering Works, Ltd.
Montreal, Que., Canada

IN A HIGHLY COMPETITIVE MARKET, the small jobbing foundry often finds that the bulk of available business goes to large, well-equipped shops with close laboratory control, leaving the small foundry with repair work and the making of special alloy iron castings in fairly small quantities. Thus, the gating and risering of these castings must result in a minimum cleaning and grinding expense, particularly since the costs of tools, equipment, and labor in the finishing department alone can wipe out the small margin of profit involved in making castings weighing 500 lb or less. Sound, high alloy castings can be produced satisfactorily and with a minimum of chipping and grinding by (1) using side risers instead of top risers, (2) gating through the risers to the castings, and (3) using small feeding connections.

Iron in the castings (except the pulverizer castings) described in this article had the following composition: carbon, 2.80-3.00 per cent; manganese, 1.10; silicon, 2.40; nickel, 20-22; chromium, 2.25-2.50. This metal has high shrinkage and readily forms dross, requiring a high pouring temperature. It should not be poured after a film forms on top. Castings of this analysis were eventually all poured in cores. The pulverizer castings described at the end of the paper were made in green sand.

Following is a description of the gating and risering used on several castings made to clean up at minimum cost and to pass a 500 psi water pressure test.

Flanged Plug Valve Body: This casting (Fig. 1) was made in sizes ranging from ½ to 14 in. in diameter and weighing from a few pounds to 400 lb. Flanges were faced and drilled, and the plug chamber bored and reamed, with the plug lapped to a perfect fit. All machined surfaces were required to be perfectly clean.

The first castings (Fig. 2) were made in green sand and were gated into the flanges with risers over the flanges. Shrinkage was found at *A* and *B* and numerous gas holes and sand or dross inclusions were discovered in the plug chamber during machining.

Gates were then changed from the flanges to both sides of the plug chamber, with risers also over the lugs where the shrinks occurred (*C* and *D* Fig. 2). The shrinks were almost eliminated, but gas holes and dross were as bad as ever.

Next, dry sand molds were made, using side risers

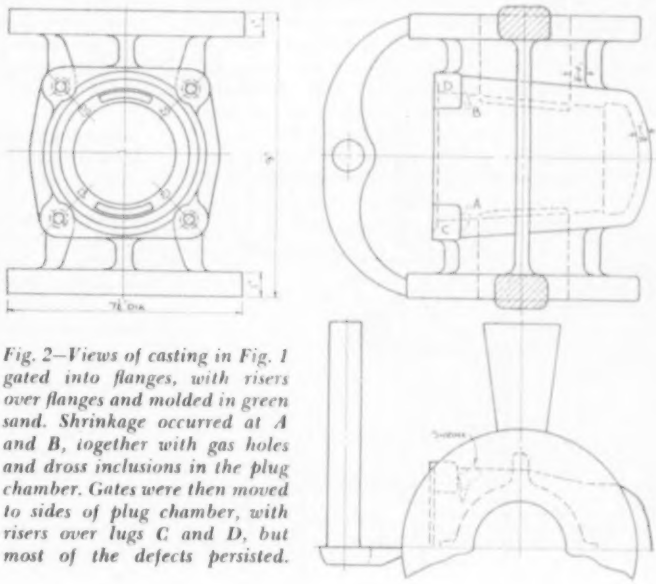


Fig. 2—Views of casting in Fig. 1 gated into flanges, with risers over flanges and molded in green sand. Shrinkage occurred at A and B, together with gas holes and dross inclusions in the plug chamber. Gates were then moved to sides of plug chamber, with risers over lugs C and D, but most of the defects persisted.

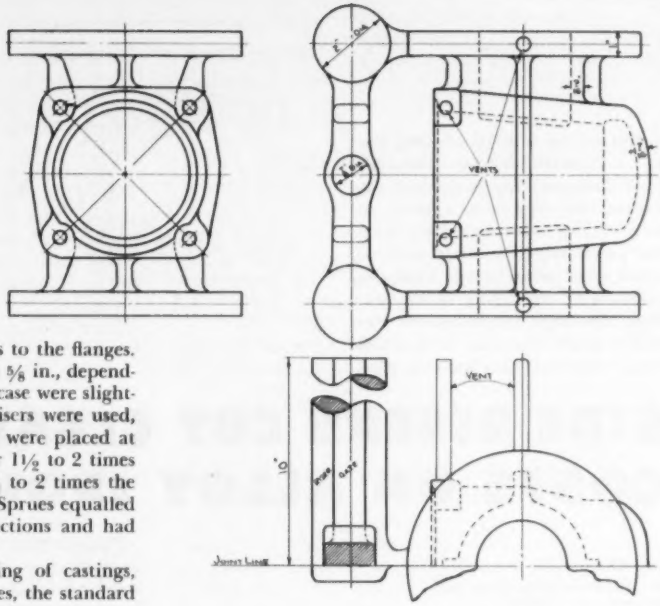


Fig. 3—Final gating and risering of casting shown in Fig. 1 and 2. Dry sand molds were made using side risers and gating through the risers to flanges. Top risers were eliminated.

(Fig. 3), and gating through the risers to the flanges. Feeding connections varied from ¼ to ⅝ in., depending upon flange thickness, and in this case were slightly narrower than the flange. No top risers were used, but vents small enough to set quickly were placed at the high points. Risers had a diameter 1½ to 2 times the flange thickness and extended 1½ to 2 times the height of the cope half of the pattern. Sprues equalled in cross-sectional area the riser connections and had dirt traps on the runners.

After some experimenting, sectioning of castings, and adjusting riser and connection sizes, the standard

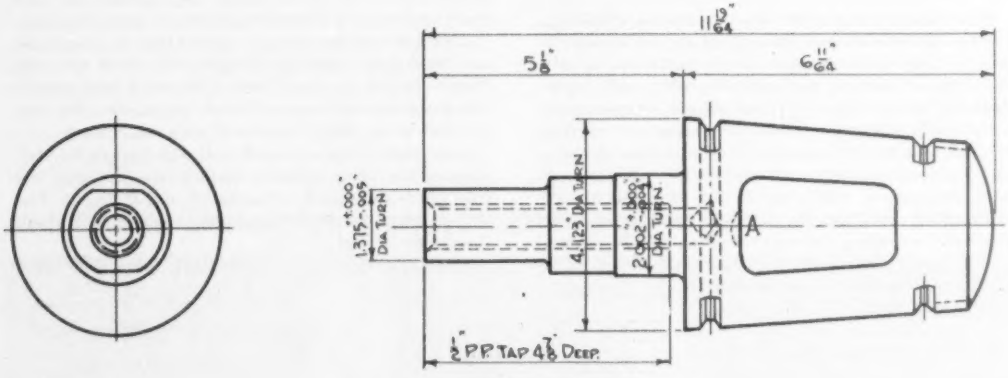


Fig. 4—Valve plug castings up to 200 lb molded upright in green sand with top riser had shrinkage at A.

described was found to be a good guide to determining gate and riser sizes for various sizes of valves of this design. Screwed valve bodies were made in the small sizes. When gated through risers located on each side of the plug chamber, these were found to be sound and clean.

Plug Casting. These castings (Fig. 4) ranged in weight from a few pounds to 200 lb each and were machined all over. A hole was tapped down the stem to within ⅜ in. of the port opening, with 5/16-in. holes connecting the lubricating grooves.

The castings were required to be perfectly clean

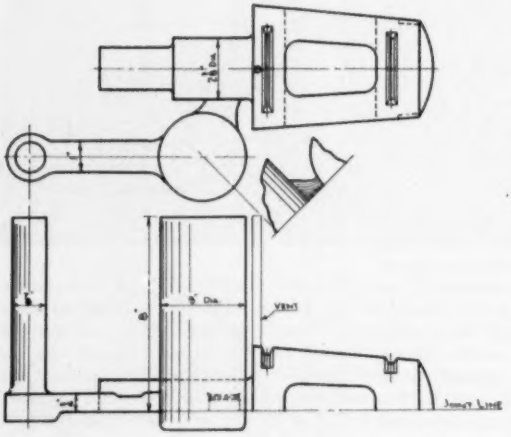


Fig. 5—Dry-sand molded on side with side riser, plug valves were sound. Riser is 1½-2 times stem diameter.

and sound, and all machining had to be completed before a test could be made. If a leak occurred, both time and cost of machining were lost. Such castings were easily made in gray iron but the same procedure did not work for high alloy iron. When molded in green sand, the castings contained gas holes, and dross and shrinkage occurred as shown at *A* in Fig. 4.

A change was made to dry sand molds, which were poured on end and gated at the shoulder with a riser on the stem through the cope. The shrink still persisted, although gas holes and dross were eliminated.

Finally, as shown in Fig. 5, side risers were used and the castings were molded horizontally. The castings were sectioned and shrinks were found very near the riser. Dimensions of risers and connections were changed until a sound, clean casting was produced.

The riser was 1½ to 2 times the diameter of the stem, with a small connection measuring from ⅜ to ¾ in. thick by ¾ to 1½ in. wide, according to the size and weight of the casting.

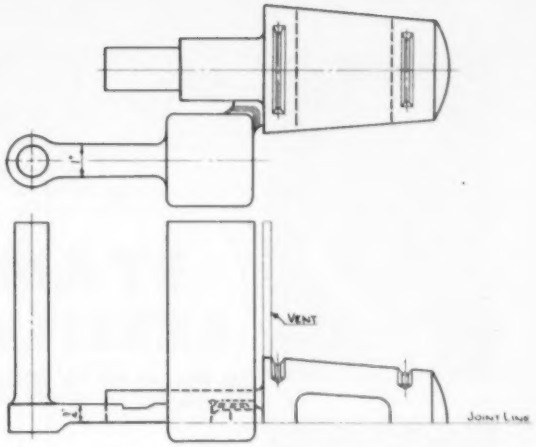


Fig. 6—Feeding above large valve plug called for riser connection into both stem and body. Square riser (not ordinarily considered best practice) used to heat corner and in-gate to promote feeding succeeded when the round riser failed.

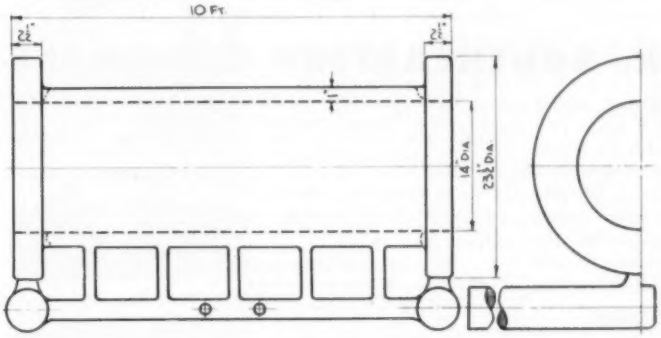


Fig. 7—Blowpipe at left cracked in flanges and showed shrinkage until top risers were replaced with the side risers shown in illustration.

Small plugs were cast two in a mold, with one riser between the stems feeding both. The riser was made larger and higher and proved satisfactory. Very large plugs were harder to feed. It was found that a square riser with a connection extending into both the stem and shoulder (Fig. 6) proved best, with ½ to ¾-in. vents at the highest point.

Blow Pipe Casting. In castings made in a copper-bearing, high alloy iron some trouble was experienced with cracking of flanges at the body on blow pipes (Fig. 7) and there was shrinkage under the top risers. Chills laid around the flanges eliminated the cracking but required extra attention in molding and preparation. Shrinkage still occurred under the risers. Side risers were then tried instead of the top risers, resulting in elimination of shrinkage. Cracking did not recur when use of chills was discontinued. In this casting, the wall was 1 in. and the flanges 2½ in. thick.

Pulverizer Ball. A perfectly round ball for pulverizer service is difficult to make, particularly when the 8-in. ball contains 4.75 per cent nickel and 1.50-1.75 per cent chromium and undergoes high shrinkage. The first of these balls was cast with a large riser like

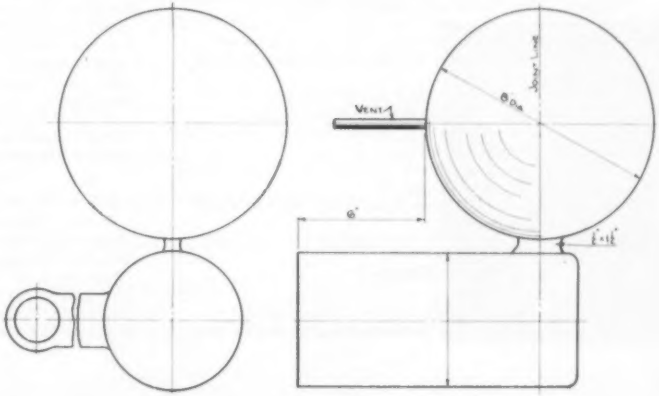


Fig. 8—Pulverizer ball was successfully cast gated through a 5½-in. side riser. Previous attempts with top riser resulted in shrink underneath which required welding.

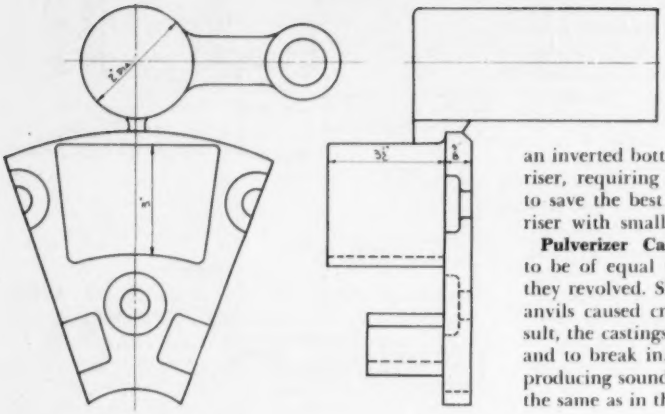


Fig. 9—Pulverizer segment with heavy lugs and bolt holes had to be gated through a side riser to eliminate both shrinkage and cracking.

an inverted bottle on top. Shrinks occurred under the riser, requiring welding and grinding to a template to save the best castings. On the next attempt a side riser with small feeding connection was satisfactory.

Pulverizer Casting. These castings (Fig. 9) had to be of equal weight to balance the disc on which they revolved. Shrinkage voids in the heavy bosses or anvils caused cracks and weight differences. As a result, the castings were difficult to assemble on the disc and to break in. Side risers proved very successful in producing sound castings of this design. The alloy was the same as in the pulverizer ball.

PLAN WISCONSIN, SOUTHEASTERN REGIONALS

Almost duplicating last year's dates, two widely separated regional foundry meetings will again provide foundrymen of north and south with an opportunity to compare notes. Scheduled for February 7 and 8 at the Schroeder Hotel, Milwaukee, is the Wisconsin Regional Foundry Conference. The Southeastern Regional Foundry Conference (called the Birmingham Regional in previous years) will be held February 21 and 22 at the Tutwiler, Birmingham.

WISCONSIN REGIONAL CONFERENCE

Thursday, February 7

9:00 a.m.—Registration.

10:00 a.m.—Welcoming Address. Dean M. O. Withey, College of Engineering, University of Wisconsin.

10:30 a.m.—General Meeting. *"Making the Foundry a Better Place in Which to Work,"* Kenneth M. Morse, Director of Safety & Hygiene and Air Pollution, A.F.S.

12:00 noon—Luncheon. *"1952 International Foundry Congress,"* Wm. W. Maloney, secretary-treasurer, A.F.S.

2:15 p.m.—Sectional Meeting.

Malleable—*"Quality Control in the Malleable Foundry,"* George Verbecke, John Deere Malleable Works, East Moline, Ill.

Non-Ferrous—*"The Cleaning Room,"* Martin G. Dietl, Schaible Co. Cincinnati.

Gray Iron—*"Basic Cupola Operation,"* John P. Holt, Basic Refractories, Inc., Cleveland.

Steel—*"Steel Foundry Cleaning Room Practices,"* Charles W. Briggs, Steel Founders' Society of America, Cleveland.

Pattern—*"New Trends in Pressure Cast Equipment,"* Steve Denkinger, Atlas Plastic and Aluminum Plate Co.

4:00 p.m.—Sectional Meetings.

Malleable—*"Application of Oxygen in the Malleable Foundry,"* Lee H. DeWald and John P. La Pota, National Cylinder Gas Co., Chicago.

Non-Ferrous—*"Some Problems in a Non-Ferrous Pressure Castings Foundry,"* John W. Bolton, Lunkenheimer Co.

Gray Iron—*"Resin Binders,"* J. Allen Wickett, Monsanto Chemical Co., Springfield, Mass.

Steel—*"Standardization of Casting Practice,"* A. S. Grot, Edward Valves, Inc., East Chicago, Ind.

Pattern—*"Modern Pattern Shop Equipment,"* Robert Melius, Delta Mfg. Co., Milwaukee.

6:30 p.m.—Banquet. Speaker to be announced.

Friday, February 8

10:00 a.m.—Sectional Meetings.

Malleable—*"The Mechanics of Foundry Mechanization,"* Russell J. Anderson, Belle City Malleable Iron Co., Racine, Wis.

Non-Ferrous—*"Production Control for Small Foundries,"* Harold E. Younger, Standard Plating Rack Co., Chicago.

Gray Iron—*"Why Test Sand?"* Bradley H. Booth, Carpenter Brothers, Inc., Milwaukee.

Steel—*"Work Simplification,"* Milton E. Annich, American Brake Shoe Co., Mahwah, N. J.

Pattern—*"Pattern Engineering in Conjunction with the F.E.F. Program,"* George K. Dreher, executive director, F.E.F.

12:00 noon—Luncheon. *"1951 International Foundry Congress,"* Walter L. Seelbach, President, A.F.S.

2:30 p.m.—Sectional Meetings.

Malleable—*"The Why and How of a Preventative Maintenance Program,"* Thomas F. Butler, Ford Motor Co.

Non-Ferrous—*"Information Forum,"* panel consisting of John W. Bolton, Lunkenheimer Co.; Walter W. Edens, Alloy Engineering & Casting Co.; Theodore E. Kramer, Wm. F. Jobbins, Inc.; Bradley H. Booth, Carpenter Brothers, Inc.; and Arthur K. Higgins, Allis-Chalmers Mfg. Co.

Gray Iron—*"Sand, Metal, or Men,"* Harry E. Gravlin, Ford Motor Co., Dearborn, Mich.

Steel—*"Factors which Determine the Performance of Castings under Severe Conditions of Service,"* William S. Pellini, Naval Research Laboratory, Washington, D. C.

Pattern—*"Core Box Design and Rigging for Core Blowing,"* Harry J. Jacobson, Industrial Pattern Works, Chicago.

SOUTHEASTERN REGIONAL CONFERENCE

Thursday, February 21

9:00 a.m.—Registration.

10:00 a.m.—*"Castings vs. Weldments,"* Paul H. Stuff, Ross-Meehan Foundries, Chattanooga, Tenn.

11:15 a.m.—*"Comparison of Core Binders,"* Warren C. Jeffrey, University of Alabama.

12:30 p.m.—Luncheon. *"Your A. F. S.,"* I. R. Wagner, Vice-President, American Foundrymen's Society.

1:45 p.m.—*"The Why of Gate and Feeder Design of Castings,"* Fred G. Sefing, International Nickel Co., Inc., New York.

3:00 p.m.—*"Demonstration of Core Making,"* representatives of Stockham Valves & Fittings, Birmingham, Ala.

4:30 p.m.—*"Cupola Deoxidation Improve: Machinability,"* Frank S. Kleeman, Pittsburgh.

8:00 p.m.—Entertainment.

Friday, February 22

9:00 a.m.—Plant Visitation.

1:30 p.m.—*"Sources of Trouble in Cupola Operation,"* Walter R. Jaeschke, Whiting Corp., Harvey, Ill.

3:00 p.m.—*"Foundry Modernization,"* Ray H. Moore, Claude B. Schneible & Co., Detroit.

4:30 p.m.—*"Quality Control,"* Max Kuniansky, Lynchburg Foundry Co., Lynchburg, Va.

7:00 p.m.—Banquet.

NOMINATE A.F.S. OFFICERS AND DIRECTORS

I. R. Wagner

C. L. Carter

I. R. Wagner, Electric Steel Castings Co., Indianapolis, A.F.S. Vice-President, has been nominated to succeed Walter L. Seelbach of Cleveland as President of the American Foundrymen's Society for 1951-52.

Nominee for 1951-52 A.F.S. Vice-President to succeed Mr. Wagner is Collins L. Carter, Albion Malleable Iron Co., Albion, Mich.

Nominate Six New Directors

Nominated to serve three-year terms as National Directors of the Society, beginning in 1952 are:

Martin A. Fladoes, president, Sivyer Steel Casting Co., Milwaukee.

H. G. Robertson, works manager, American Steel Foundries, Alliance, Ohio.

J. O. Klein, vice-president and secretary, Texas Foundries, Inc., Lufkin, Texas.

A. D. Matheson, general manager, French & Hecht Division, Kelsey-Hayes Wheel Co., Davenport, Ia.

Walter J. Klayer, works manager, Aluminum Industries, Inc., Cincinnati.

Walter L. Seelbach, Superior Foundry, Inc., Cleveland, whose term as A.F.S. National President expires in 1952, will continue as a National Director of the Society for one year.

H. G. Robertson

M. A. Fladoes

A. D. Matheson

W. J. Klayer

J. O. Klein

W. L. Seelbach

Elections at 1952 Foundry Congress

Election of officers and directors will take place during the Annual Business Meeting of the Society, to be held during the A.F.S. International Foundry Congress & Show, Atlantic City, May 1 through 7. Newly-elected officers and directors will take office immediately following the annual meeting of the Board of Directors next July.

National Directors who will complete their three-year terms in July are:

Thomas E. Eagan, chief metallurgist, Cooper-Bessemer Corp., Grove City, Pa.

L. C. Farquhar, Sr., works manager, American Steel Foundries, East St. Louis, Ill.

Vincent J. Sedlon, president, Master Pattern Co., Cleveland.

F. G. Sefing, metallurgist, International Nickel Co., New York.

L. D. Wright, plant manager, United States Radiator Co., Geneva, N. Y.

Walton L. Woody, vice-president and general mana-

ger, National Malleable & Steel Castings Company, Cleveland.

Nominations for officers and directors of A.F.S. for election at the 1952 Annual Business Meeting are announced in accordance with the By-Laws which require that the report of the Nominating Committee be published at least 60 days prior to the Meeting. Thereafter and at any time 45 days prior to the date of the Annual Business Meeting additional nominations may be made by written petition filed with the secretary of the Society and signed by 35 members in good standing.

Should no candidates be nominated by petition, the secretary *"shall, at the annual Business Meeting, cast the unanimous ballot of all members for the election of the candidates named in the report of the Nominating Committee, and as published to the membership"* as prescribed by the By-Laws. If additional candidates are nominated by petition, the By-Laws require that elections shall be by letter ballot.

The seven members of the Nominating Committee, in addition to the two immediate past presidents of the Society, are chosen by the Executive Committee of the Board of Directors from lists of candidates submitted by the various eligible chapters. One member of the Nominating Committee may be from the list of members in the United States, Canada and Mexico not residing in a chapter area. A chapter is eligible to have a member on the committee if it has not been represented for two years.

Continuing National Directors of A.F.S. are:

(Terms expire in 1953)

J. J. McFadyen, general manager, Galt Malleable Iron Co., Galt, Ont., Canada.

J. O. Ostergren, president, Lakey Foundry & Machine Co., Muskegon, Mich.

Frank W. Shipley, foundry manager, Caterpillar Tractor Co., Peoria, Ill.

James Thomson, chief engineer, Continental Foundry & Machine Co., East Chicago, Ind.

E. C. Troy, foundry consultant, Palmyra, N. J.

(Terms Expire in 1954)

Harry W. Dietert, president, Harry W. Dietert Co., Detroit.

A. L. Hunt, works manager, National Bearing Div., American Brake Shoe Co., St. Louis.

James T. MacKenzie, technical director, American Cast Iron Pipe Co., Birmingham.

Martin J. O'Brien, Jr., works manager, Symington-Gould Corp., Depew, N. Y.

A. M. Ondreyco, plant manager, Vulcan Foundry Co., Oakland, Calif.

HOLD MIDYEAR MEETING OF SOCIETY BOARD

OFFICERS AND DIRECTORS of A.F.S. met in Chicago, December 13 and 14 to consider the midyear status of Society activities, the Safety & Hygiene and Air Pollution Program, and lay final plans for the 1952 International Foundry Congress to be held in Atlantic City, May 1-7. National President Walter L. Seelbach, Superior Foundry, Inc., Cleveland, presided.

President Seelbach stated that at the last meeting of the National Castings Council, members present indicated willingness to make the original solicitation for Safety & Hygiene and Air Pollution funds to their memberships and those segments of the foundry industry which they represent. A.F.S. will go ahead, he said, with special solicitations, but will withhold general solicitation until after the original approach to the industry by the trade associations represented in NCC.

The Board instructed Secretary-Treasurer Wm. W. Maloney to express sincere appreciation for the willingness of NCC members to cooperate with A.F.S. toward the successful conclusion of the solicitation of funds for carrying on the Safety & Hygiene and Air Pollution Program on behalf of the entire foundry industry.

The Board voted to recommend for two international offices in 1952, L. N. Shannon, Stockham Valves & Fittings, Inc., Birmingham, Ala., as vice-president of the International Committee of Foundry Technical Associations, and H. Bornstein, Deere & Co., Moline, Ill., as vice-chairman of the International Committee on Testing Cast Iron. Both are past presidents of A.F.S. It is understood that Mr. Shannon will succeed to the presidency of the International Committee of Foundry Technical Associations in 1953 and will attend the International Foundry Congress scheduled for Paris that year.

Technical Director S. C. Massari reported on the 1952 Convention program, general and special publications, A.F.S.-sponsored research, and over-all technical activities. Acting on the comments of 78 per cent of the technical committee personnel canvassed who expressed themselves in favor of the idea, the Board approved elimination of stenotype reporting of oral discussion at the 1952 Convention technical sessions. It was agreed that all written discussion of the 1952 papers should be published and that oral discussion should be reported by technical reporters to be arranged by the technical director.

A petition from 31 University of Michigan students for the formation of a student chapter was approved provisionally, contingent upon fulfillment of all requirements for student chapter status.

Officers and directors attending the mid-year meeting of the Board were: President Walter L. Seelbach; Vice-President I. R. Wagner, Electric Steel Castings Co., Indianapolis; T. E. Eagan, Cooper-Bessemer Corp., Grove City, Pa.; L. C. Farquhar, Sr., American Steel Foundries, East St. Louis, Ill.; V. J. Sedlon, Master Pattern Co., Cleveland; Past President Walton L. Woody, National Malleable & Steel Castings Co., Cleveland; Lloyd D. Wright, U. S. Radiator Co., Geneva, N. Y.

J. J. McFayden, Galt Malleable Iron Co., Galt, Ont., Canada; Frank W. Shipley, Caterpillar Tractor Co., Peoria, Ill.; James Thomson, Continental Foundry & Machine Co., East Chicago, Ind.; E. C. Troy, Palmyra, N. J.; Harry W. Dietert, Harry W. Dietert Co., Detroit; A. L. Hunt, National Bearing Div., American Brake Shoe Co., St. Louis; Martin J. O'Brien, Jr., Symington-Gould Corp., Depew, N. Y.; and A. M. Ondreyco, Vulcan Foundry Co., Oakland, Calif.

Is it worthwhile converting a smoothly operating acid cupola to the comparatively unproved basic cupola? "Yes," says the author of this article, who bases his opinion on personal observations and experiences in installing and operating basic cupolas in four foundries. Designed to aid the foundryman in overcoming difficulties involved in converting from acid to basic cupola operations, this article answers questions on advantages, applications, installation, operation, and maintenance of the basic cupola asked most frequently by operators.

BASIC CUPOLA OPERATION

John P. Holt
Sales Engineer
Basic Refractories, Inc.
Cleveland, Ohio

Operator installing a granular basic refractory lining in cupola by means of an air-placement gun.

STORY OF THE BASIC CUPOLA has a good many unwritten chapters. Although such cupolas have been operating successfully in Europe for some years, it has not been more than two years since real interest in the process developed in the United States. Perhaps 40 basic cupolas are running in this country today, operating under nearly every foundry condition to produce a wide variety of special products, as well as ordinary gray iron. Many theories on the why's and wherefore's of the basic cupola, while interesting, are as yet unproved.

Nevertheless, information obtained right on the foundry floor has shown that there are a number of good reasons for converting a smoothly operating acid cupola to a basic cupola:

(1) Sulphur content can be reduced by 50 per cent with little difficulty, and with care can be cut down much farther.

(2) Basic cupolas operate with a charge of steel scrap and a little remelt—a strong inducement to conversion in view of today's pig iron shortages.

(3) Carbon content of metal may be raised well beyond carbon content of the charge, and can be controlled with a fair degree of certainty.

(4) Drops are clean, and patching and cleaning of cupolas is relatively simple.

(5) Brick lining of the cupola will last indefinitely with reasonable care.

(6) Operators report that savings in labor and quantity of materials have more than counterbalanced the higher cost of basic refractories.

Depending upon the type of product to be made, it may be necessary to raise the cupola's tuyeres so that a thick slag blanket is provided. Here, the sulphur content of the tapped metal is the governing factor—if sulphur must be under 0.03 per cent, it is advisable to have an average of 11 in. of slag on the molten iron. If sulphur as high as 0.07 per cent is allowable, 6 in. will do.

Slag holes of rear slagging cupolas are subject to severe erosion in basic operations. Consequently, it is dangerous to have them too close to the tuyeres. The top of the finished slag hole should be at least 4 in. below the bottom of the tuyeres.

Acid and Basic Slag Holes Similar

Basic slags and acid slags have different temperature-viscosity characteristics, but generally slag hole openings and slag troughs successful in acid practice will do for basic. Experiments are currently being conducted with bronze and cast iron water-cooled slag holes, but these are still in the experimental stage and there is obvious danger of steam explosion in such a setup.

Basic brick lining of the cupola is of magnesite. This brick is heavy and dense, has a relatively high thermal conductivity, and is apt to spall and crack badly when heated or cooled rapidly. Magnesite brick should not be used as the working surface of the cupola, but will resist the chemical attack of basic slag if the monolithic inner lining fails.

Basic cupola lining is expensive, the materials costing several times as much as comparable acid substances. It is thus preferable to use basic lining only

Operator shown with air-placement gun and equipment used in installing granular basic refractory lining.

in melting zones and wells. In the upper portions of the cupola, the lining need not be changed to convert to basic operations.

Rebricking must be done sufficiently far above the tuyeres to include all of the area that is regularly burned out severely. A course or two of magnesite brick is laid on the inner face over a fireclay backing, with an insulating material between the fire brick and the steel shell. Magnesite brick used should be at least 4½-in. thick for small cupolas and 9-in. thick for cupolas of more than 54-in. inner diameter. An excellent lining consists of 9-in. magnesite wedge brick, but two courses of standard arch bricks and straights are satisfactory. If the cupola is so small that there is no room for a course of regular fireclay brick behind the magnesite brick, the clay brick may be omitted, but it is advisable to put on at least an inch of good insulating material next to the shell.

Insulation Is Important

Magnesite conducts heat two or three times as fast as fireclay, making insulation an important factor. Since magnesite brick spalls badly when subjected to thermal shock, it is better to lay the brick up with a basic mortar, allowing ¼-in. expansion joints for every foot on the lining's perimeter. A simpler construction involves laying brick up dry so that expansion and contraction is taken up by the brickwork itself.

Original installation of a basic lining requires that provision be made for a 2 to 4 in. layer of monolithic material over the magnesite brick. This monolith should be applied after the magnesite brick has been thoroughly dried, on the day before the cupola is scheduled to go into operation.

The granular basic refractory preferred by the author is a mixture of specially prepared dead burned dolomite and stable dead burned high-magnesia clinker and is designed for application through a pneumatic refractory gun. This mixture was originally developed for patching vertical walls of steelmaking furnaces. It contains a small quantity of chemical bonds, which with the addition of a little water, permit the material to adhere to the cupola's vertical brick lining.

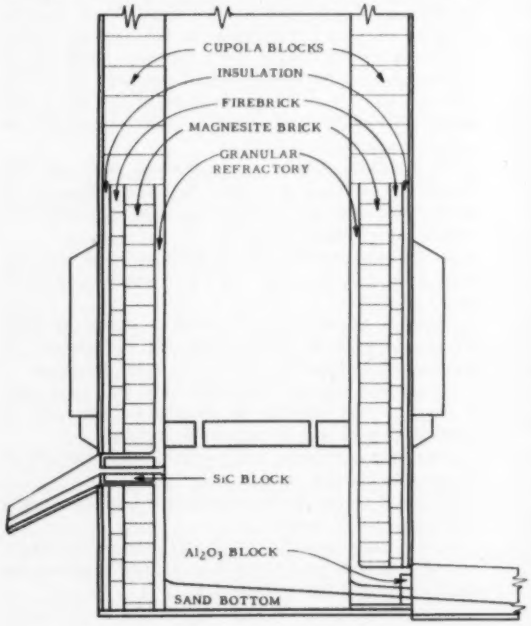
Granular basic refractory is applied with a gun to the magnesite brick, forming the cupola's working surface. The cupola may be brought back to its original diameter this way after each run. Generally, during the cupola run the well is little affected, but the melting zone above the tuyeres is washed away at a rate of about ½-in.-per-hr. Actually, erosion during the first two hours is a little faster than this, and after 10 or 12 hours, is slower.

Granular basic refractory patches up to 8-in. thick are successfully being applied to linings of cupolas running as long as 17 hours. When a heavy (4 or more inches) patch is to be applied, it is better to have the cupola walls hot enough to dry out the material during application.

Applying the lining through a pneumatic refractory gun is relatively easy. To conserve the refractory, a tarpaulin and wheelbarrow are placed under the cupola to catch dropped material, which may be re-used after drying overnight. Since the drop contains a high percentage of large particles, it is advisable to mix it with about 30 per cent of a refractory whose top grain size is smaller, but whose composition is chemically identical.

For continuous-tap cupolas, granular basic refrac-

Cross-section of cupola, showing location and type of refractories needed in basic cupola operation.



tory may be used successfully for tap holes, and to some extent for lining spouts and forehearths. Although this mixture has worked out satisfactorily where intermittent tapping is used, it has been found that a solid brick better withstands the constant jar of plugging and opening the tap hole. One operator reports using a drilled 99 per cent alumina brick for facing off the outside of the tap hole with excellent results.

Slag hole problems on front-slagging cupolas are not too difficult to solve. Here a tap hole, fire brick spout and dam covered with an inch or two of granular basic refractory will work very well. Although there is one cupola tapping 180 tons of gray iron a day in a 17-hour run through a basic refractory tap hole, trouble has been encountered in some front slagging cupolas. One foundry uses a carbon lined tap hole, while another is experimenting with one made from electrically fused magnesia.

Slag Hole Enlargement Presents Difficulties

Slag hole enlargement is a chronic difficulty if slag is run out the back of the cupola. One foundryman uses a granular basic refractory slag hole. Another has two such slag holes. He uses one until it is too large, then plugs it and opens the other. In the author's opinion, the finest slag hole is made from a carbon-bonded silicon-carbide block with a 1-in. hole through it. The block is set in place with basic refractory.

The following slag hole materials have been tried unsuccessfully a number of times:

(1) Fireclay brick, ganister, or fireclay—wash out when hot basic slag hits them.

(2) Magnesite brick—cracks and disintegrates as soon as heat hits it.

(3) High alumina brick (previously mentioned as a facing for tap holes on intermittent-tap cupolas)—destroyed on contact with basic slag.

Eliminate as Much Silica as Possible

Probably the most important factor contributing to erosion of basic refractories in the cupola is the amount of silica entering with the charge. Most silica comes from molding sand that adheres to gates, risers, pigs and scrapped castings in remelt scrap, while some is derived from the silicon content of the metallic charge. It is well to bear in mind that silica is an acid oxide and that although it is impossible to exclude it entirely from the slag, reasonable precautions should be taken to exclude as much of it as possible.

Chemical analyses of slags procured from a large number of cupola runs with charges of widely different silica content do not show any significant change in their basicity ratio. This ratio, which is the sum of the percentages of definitely basic oxides divided by the total percentages of definitely acid ones, generally stays around 2.5. All of these slags removed sulphur, with the quantity removed seemingly more dependent upon average slag thickness than upon variations in chemical composition.

These cupolas were lined with a granular basic refractory which contains free lime. It is thus important to remember that an excess of silica in slag will cause a rapid attack on the basic refractory lining until the slag's composition returns to normal. In other words, the basic refractory acts as a chemical buffer, neutralizing excess acid oxides until the monolith is completely dissolved.

The magnesite brick then is attacked, and despite large and continuous silica additions, the slag will not become permanently acid until it gets through to the fireclay back-up brick. When this occurs, the only recourse is to stop the cupola and drop the bottom to prevent a run out.

Excess silica in slags promotes a rapid attack on the slag hole as well and in general contributes nothing to the operation except to promote slag fluidity. Highly basic slags of more than 3.0 basicity ratio are obtainable under certain conditions, but their viscosity is so high they are difficult to keep flowing through the slag hole and very probably do not remove sulphur efficiently, despite a favorable-appearing chemical analysis.

It is easiest and cheapest to cover the bottom of the cupola with heap sand rammed in placed to a contour that permits the cupola to drain easily—just as is done in acid practice. No erosion is noticeable on the interface between the sand and basic lining. Although some operators like to cover the sand with a half-inch of granular basic refractory, this is believed unnecessary and possibly harmful in that it occasionally forms a dense, tough layer that prevents a clean drop.

Most noticeable difference in operating characteristics between acid and basic cupolas is in the appearance of the slag. The operator immediately wants to know its chemical analysis, but it is difficult to obtain a good chemical sampling of the slag from the cupola. Consequently, many published results of slag analyses show variations that are temporary in nature, or never

Wheelbarrow and tarpaulin in place under cupola prior to installation of basic monolithic lining.

really exist because they result from segregation of slag constitutents produced as the sample solidifies.

The author has not yet seen any slag analyses that relate to any important operating characteristics of the cupola, and believes that unless there is some well-defined purpose slag analysis is a waste of time.

Expecting significant results from a lump of slag picked from the floor is futile. If analyses are made, samples should be obtained as a thin sheet to minimize segregation effects. A clean piece of steel plate should be held briefly under the slag stream. All slag that sticks to it should be carefully removed, crushed, and ground. The sample should be large enough to be quartered several times before chemical analysis. What results—it should be kept in mind—is an analysis of a bit of slag that happened to be running out of the cupola when the plate was held there to catch it.

Slag Forecasts Melt Results

Watching the slag is the most promising method of chemical control, because it forecasts results of the melt. Convenient for this is a cast iron mold with a cavity about 3 in. in diameter by about 1 in. deep. A long handle is attached to the mold, which is then filled with slag directly from the cupola every 15 minutes.

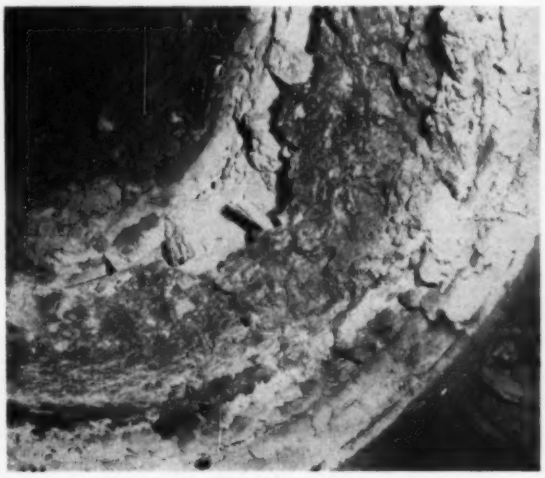
If all is going well, the upper surface of the cooled slag pancake will appear dull brown in color and will be speckled with lighter brown dots. Its fracture will be granular and somewhat porous, especially in the upper half. This slag is highly basic and the iron oxide is low.

If the slag should turn black and its surface become shiny, the iron oxide has gone up and in a few minutes the metal will lose silicon, pick up sulphur and appear cool, and its chill will increase. To prevent too much bad metal, coke volume must be doubled on the charge after the slag appearance changes. In a few minutes the slag will return to normal, and so will the metal. These black slags also show a granular fracture, but generally are not as porous as the brown slags.

Slags that appear greenish-black on both the top and bottom of the pancake, and show a glassy fracture, are acid slags. This condition may be corrected by increasing the limestone addition, but it usually means that the basic lining has been cut through to the fire brick and the cupola is no longer basic. This occurs under unusual circumstances, such as when a large amount of sand clings to the remelt scrap, or the basic lining fails.

Slag appearances described are as they appeared to the author while watching cupolas making nodular iron. Under other conditions the slags might look different, and it is necessary for each operator to work out his own method of evaluation.

A major peculiarity of basic slags is their lack of affinity for coke. This may be observed after the cupola bottom is dropped, when the residual coke is found to be clean, with no slag sticking to it. Occasionally, small pieces of coke are discharged at the slag hole. These, too, are clean and since it is known that basic steelmaking slags do not wet coke, it is reasonable to assume this phenomena is true of basic cupola slags as well.

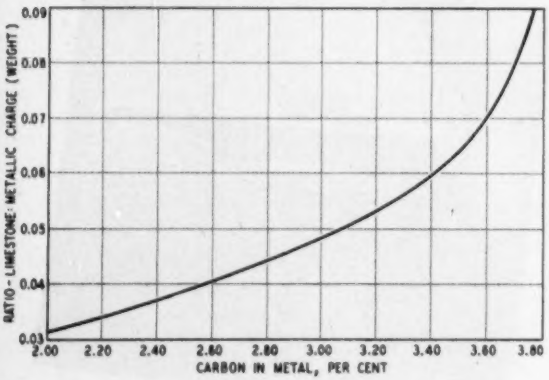


View from bottom of cupola showing inside cleaned out before installing monolithic basic refractory lining. Slag hole and two tuyeres are visible.

This peculiarity seems to have a bearing on most chemical reactions occurring in the cupola. In particular, uncoated pieces of coke in contact with slag and metal probably account for the low iron oxide content of the slags and the ease with which the metal will pick up carbon.

Sulphur, carbon, silicon, phosphorus, and manganese are the most important elements in cupola operation. Sulphur removal is helped by higher temperatures, lower blast pressures, and larger slag volumes. One basic cupola presently in operation is lined down to 48 in., uses 10 to 11 oz cold blast, and a 1200-lb metallic charge containing about 0.15 per cent sulphur. With 120 lb of limestone, 11 in. of slag cover the metal. The sulphurs come out at about 0.03 per cent. If sulphurs as low as this are not needed, the

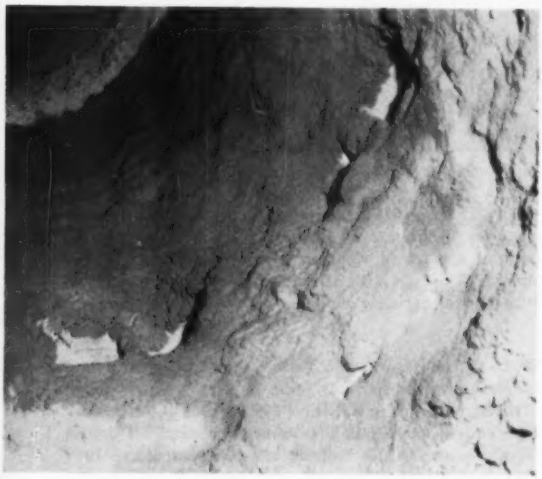
Limestone-to-metal ratio should be varied with carbon content in the basic cupola. Suggested ratios can be used as a starting point in establishing practice.



slag hole should be lowered and limestone additions cut—85 lb should give about 0.04 or 0.05 per cent sulphur and approximately 7 in. of slag.

Mechanism of sulphur reduction is not too well understood. Under certain conditions, sulphur in the metal will combine with lime in limestone to form some such compound as calcium sulphide. Some of this is oxidized by the blast to form sulphur dioxide, which escapes out the stack. Calcium sulphide, however, will not form unless the slag is highly basic, and the iron oxide content is low, i.e., containing much more lime than silicon.

The same factors that lower sulphur increase the metal's carbon content. It is sometimes easier to keep the blast, coke, and metallic change constant and vary



Another view of cupola on opposite page, showing interior after basic monolithic lining was blown in.

the carbon content with changes in the limestone additions. One cupola operator uses 11 oz cold blast pressure, 17 per cent coke, and about 2.60 per cent carbon in his charge. With a 6 per cent limestone addition, he gets 3.40 per cent carbon; with 8 per cent limestone, 3.60 per cent carbon; and with a 10 per cent addition, 3.80 per cent carbon.

Appearance of the flame at the charging door indicates that the gases contain less carbon when the limestone addition is heavier, and more carbon with less limestone. If less limestone is desirable and a high carbon content is needed, more coke may be added. Because there is greater erosion of the basic lining during the early stages of the cupola run, it is generally more efficient to take advantage of this extra lime by cutting limestone additions approximately 20 per cent on the first several charges.

Slag fluidity may be improved by adding fluorspar to the charge. The average addition would be about 8 lb of fluorspar to each 100 lb of limestone.

Silicon losses amount to more than twice the loss experienced in comparable acid practice. To combat this, more silicon may be added to the charge, or better still, if the process permits, should be added to the stream of metal entering the ladle or forehearth. Silicon is burned readily to silica, which dissolves readily in basic slag. This has the unfortunate result of increasing slag volume while decreasing the slag's ability to remove sulphur.

To offset the effects of large silicon losses, more limestone must be added, or the slag will satisfy its lime requirements by attacking the basic lining. Silicon losses may be minimized by adding more coke to the charge and/or reducing the blast pressure. Before large silicon losses are evident in the metal, they may be anticipated by the appearance of the slag, and corrections can be made before much damage is done.

Phosphorus may be removed after all silicon is removed from the metal, but would result in poor cupola operation and is therefore impractical.

Manganese loss in the basic cupola, amounts to a little over half of that expected in acid practice. Manganese is oxidized by the blast to manganous oxide, which dissolves because of the large amounts of silica in acid slags, which apparently can absorb it in large quantities as a manganese silicate compound. Manganous oxide does not form compounds with the major constituents of a basic slag and its solubility is limited. Consequently, only small amounts form and manganese losses are low in the basic cupola.

Temperature of metal is dependent upon a proper combination of blast and coke. Quantities previously mentioned (11 oz blast and 15 to 17 per cent coke) are producing good, hot metal at a number of foundries and are as good as any to begin with.

Heavy Chapter, Plant Entries Foretell Greatest Apprentice Contest in '52

Six A.F.S. Chapters and several plants have already announced that they will hold preliminary contests in preparation for the 1952 A.F.S. Apprentice Contest. National Judging of the 1952 Apprentice Contest will take place at the University of Illinois' Navy Pier Branch, Chicago, on or about April 1. Deadline for Contest entries is March 15.

First prize winners in each of the five Contest divisions—Gray Iron Molding, Steel Molding, Non-Ferrous Molding, Wood Patternmaking and Metal Patternmaking—will receive round trip and Pullman fare to and from the A.F.S. International Foundry Congress in Atlantic City next May, where A.F.S. President Walter L. Seelbach will award certificates and $100 prizes to each of the five top winners.

Now in its 29th year, the Contest is open to all apprentices in the United States, Canada and Mexico who are taking a regular course of training of not less than three years' duration. Contestants, who may enter either as individuals or through a plant or chapter contest, may not be over 24 years old on the day they prepare their entries; veterans' age limit is 24 plus their length of service in the Armed Forces.

Complete information on the contest can be obtained by writing to Jos. E. Foster, Technical Assistant, American Foundrymen's Society, 616 S. Michigan, Chicago 5, Ill. In addition to regulations, A.F.S. Headquarters supplies patterns, castings and blueprints.

MODERN FOUNDRY METHODS

EQUIPMENT AND LAYOUT FOR SMALL PRODUCTION FOUNDRY

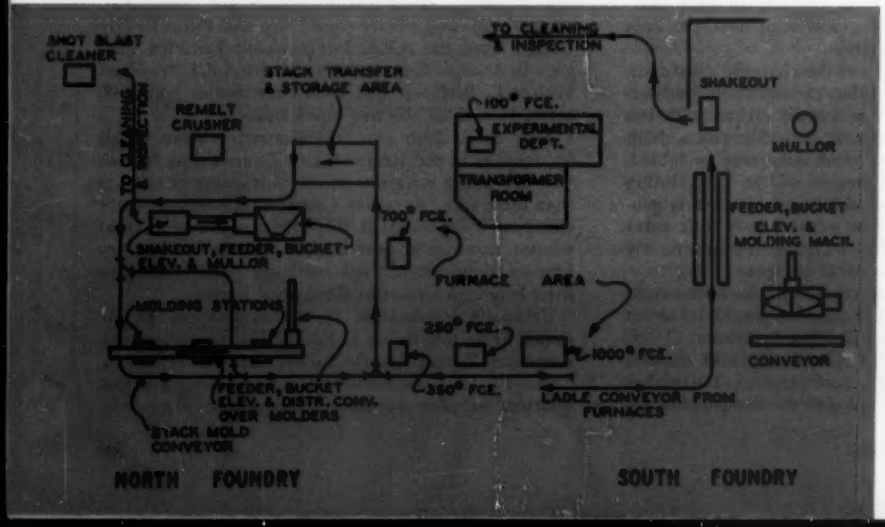
A. E. Rhoads (with name tag), president and general manager of Engineering Castings, Inc., discusses pouring basin of stack mold with Central Michigan Chapter Chairman T. T. Lloyd (at left), Albion Malleable Iron Co., Albion, Mich. Cover excludes dirt while molds stand on conveyor.

Engineering Castings, Inc., Marshall, Mich.—small, highly productive, highly efficient alloy iron foundry—played host November 28, 1951, to some 100 members of the Central Michigan Chapter of A.F.S. It was the third annual visit to a chapter-area foundry selected to give members close observation of techniques and processes and application of equipment in the chapter's most progressive shops. What the visitors saw is shown in the following four pages.

This year's visit enabled Central Michigan foundrymen to study a tightly-integrated, closely-coordinated operation turning out a high volume of castings for severe and special operating conditions. Principal items produced in volume by Engineering Castings are valve seat inserts. Output runs as high as 100,000 per day. Approximately 200 different inserts are produced for automobile and truck engines, diesel engines for automotive and marine service, and aircraft engines. Most of the inserts are Ni-Cr-Mo and Cr-Mo white irons with some steels including high chromium and W-Cr-Mo-V alloys, some W-Co-Cr alloys, and the various high nickel heat and corrosion resistant irons.

Heart of insert production is the continuous track-type conveyor with molds pushed by hand on dollies from molding to the indirect arc furnaces where they are poured direct, through the shakeout, the empty flasks returning to the molding stations. Castings from the mechanical, forced draft shakeout fall directly into tote boxes for direct transportation to cleaning and inspection. Sand returns to the conditioning unit automatically.

Inserts and other thin flatback castings which can be readily squeezed in thin mold sections—such as pump



Layout shows main work areas of North and South Foundries. Additional facilities include a parts and materials storage building, scrap storage area, offices, sand and metal testing laboratory, and compressor room. Track conveyors handle molds around North Foundry loop. Electric hoists are provided at shakeout and shot blast tumbler. In the South Foundry, molds are pushed by hand on roll conveyors.

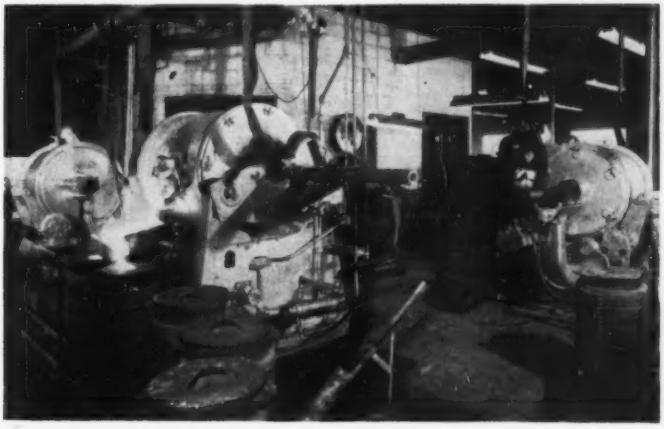
Stack molding area with three squeezer machines, numbered 1, 2, and 3 starting at the right. Partially completed stacks rest against aligning posts at right of molder 1 and left of molder 2. Completed stacks are pushed on track conveyor toward background and to the left. Pouring basins made by molder 3, who also runs sand conditioner, are positioned while molds stand behind squeezer 3 prior to moving into the furnace area. Conditioned sand is raised to belt over cylindrical hoppers by bucket elevator.

Molder 1 strikes off mold prior to removing strike-off ring and squeezing. Empty flask sections coming from shakeout (out of picture at right) move on dollies supported by two-rail track. Molder steps on pedal under stack to operate air valve for blowing loose sand off stack and pattern plate.

rotors, wearing rings, certain diesel engine parts—are stack molded. Stacks are built up of round sections ¾ in. deep, piled an average of 22 high. Each section has up to 24 cavities depending on the size of the casting. Mold cavities are filled from annular, radially-fed runners with a central sprue completely through the mold so that an entire stack can be poured at one time.

In addition to the stack molding shop, the North Foundry, Engineering Castings also has a section of the plant known as the South Foundry where alloyed gray iron castings are turned out. These castings include high speed, high pressure hydraulic pump bodies and parts, abrasion resistant parts for cement machinery, aircraft engine inserts, marine and truck diesel engine parts, and special industrial and automotive castings.

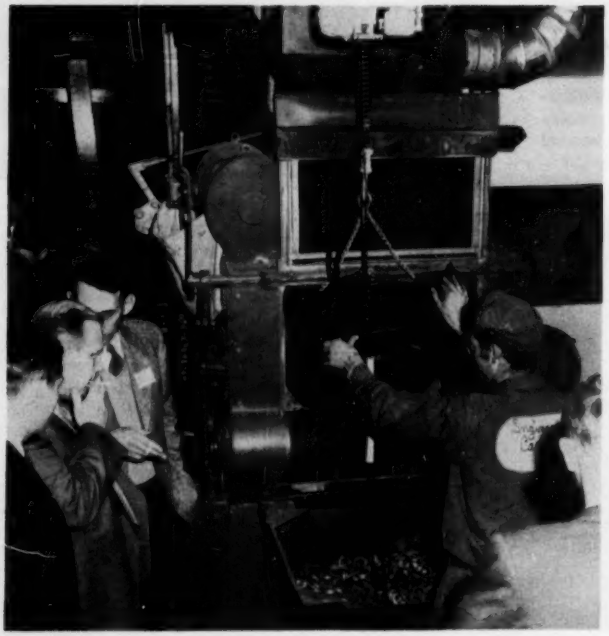
In the plant's research department, work is continually going on in development of improved alloys, molding and casting methods. Recently the company started production of ductile iron.



Three of the melting department's four indirect arc rocking-type electric furnaces. Stacks are being poured directly from the 350-lb furnace in the center. The 700-lb furnace at the left is in the middle of the rocking cycle, while operator observes progress of heat in 250-lb unit at the right. Transformers and switchgear for all furnaces are located in vault in background. Furnaces are all rear-charged, using buckets shown at right-center and electric hoist on monorail. Switch in track conveyor allows stacks to be moved to 250-lb furnace and to 1000-lb unit out of picture at right. Poured stacks from either set of furnaces travel to shakeout via track going to left.

David W. Boyd, pipe in hand, metallurgist and manager of technical control, watches pouring from 350-lb furnace with John E. Wolf, Midwest Foundry Co., Coldwater. Pouring directly from the furnace into the mold eliminates considerable handling, saves time, avoids temperature losses incurred with ladles. Metallurgical control is more accurate due to decreased exposure of metal to oxidation and temperature drop, and less time lag between completion of melting and pouring. In pouring, lugs on furnace shell engage supports in front when shell is pushed up by hydraulic cylinder located in rear. Operator controls cylinder with valve in right hand, with left hand tips T-shaped trough to first one, then the other, of the two stacks being poured.

Kenneth Loer, melting supervisor, holds shield to enable Paul Palmer, U. S. Foundry Corp., Kalamazoo, to observe arc and molten metal. Mr. Loer explains the close metallurgical control possible with the melting equipment used and points out its importance in meeting the exacting physical properties and chemical specifications to which the company's specialized castings are produced. Photographs of Central Michigan Chapter's visit to Engineering Castings, Inc., were made by John H. Eggleston, Albion Malleable Iron Co., Albion.



Plant Superintendent John W. MacMillan (with name tag) explains cleaning operation to R. B. Abbott and J. C. Grabbert of Gale Mfg. Co., Albion. Castings as well as all remelt go through shot blast tumbler. Castings are discharged into drop front tote boxes. Between pouring and blast cleaning, molds stand in cooling area, are then pushed around track conveyor past mechanical shakeout where operator hoists stack onto vibrating inclined grate. Castings slide into tote boxes, dust is exhausted by forced ventilation, sand falls through grate and returns to sand storage via belt conveyor and bucket elevator, and sprues and gates are fed into crusher which breaks them down to a size convenient for cleaning, weighing, and charging. Molding sand is a blend of southern and Great Lakes natural bank sands with southern and western bentonites added. Mulling is done in a 3½ cu ft capacity high speed unit. Discharge is onto the floor where the sand is bedded layer on layer to even out variations that might exist. Operator shovels conditioned sand onto belt conveyor which carries it to bucket elevator for overhead distribution.

⬇ *In the South Foundry, Howard J. Moore (center), plant engineer, discusses aircraft insert pattern plate with Joseph Johnson and James M. Bostwick, Steel Sales Corp., Highland Park. Most of the alloyed gray iron produced by Engineering Castings is made in the South Foundry. Also cast here are high-nickel heat, corrosion, and abrasion resistant alloys, as well as high chromium and other steels. Molding and sand systems are separate from the North Foundry. Molding equipment includes a jolt-squeeze, and jolt-squeeze-pin lift, and squeezer like those in North Foundry.*

⬆ *David E. Sherman, plant manager, holds aircraft casting to show Ralph Brooks, Brooks Furnace Co., Albion, and Donald Gaertner, Albion Malleable Iron Co., how the small gate on valve seat inserts breaks off practically flush thus minimizing snagging. Up to 5,000 pieces per hour, depending on the size and weight of the castings, are snagged by four men at the two double-wheel stand grinders. Good safety and hygiene practice exists with grinders all wearing goggles when on the job. All grinding dust is exhausted into cyclone that traps shakeout dust.*

⬆ *Russell E. Brant, assistant metallurgist, makes hardness test for Richard H. Dobbins and J. T. Ehman, Albion Malleable Iron Co. Castings from each heat are checked before stacks for that heat are released for shakeout. Complete sand testing and control is practiced because thin, small cross section castings and high ratio of metal to sand in molds requires strict adherence to close tolerances. At an inspection station, Kenneth W. Rhoads, purchasing agent, explains to A. C. Hensel, Albion Malleable Iron Co., that the tote box of inserts from the cleaning department will be segregated into good castings requiring no snagging, castings for snagging, and scrap.* ➡

CASTING PROCESS Stars on TV

(Inset) D. C. Williams, left, and Richard Bell, both of Ohio State University staff, show uses of castings in today's industry.

TELEVISION brought the foundry into the living rooms of hundreds of Central Ohio residents Sunday noon, November 18, when members of the A.F.S. Central Ohio Chapter demonstrated the actual molding and casting of metals during a half-hour telecast over Station WNBS-TV, Columbus.

Seventh in a series of *"Engineering Your Life"* productions sponsored by the Columbus Technical Council, of which the A.F.S. Central Ohio Chapter is a member, the foundry program, titled *"Of Molds and Men,"* provided the public with an insight into the foundry industry, its history and its products.

"Actors" on the program included H. W. Lownie and Harry Sanders of Battelle Memorial Institute, Columbus, Richard Bell and D. C. Williams, Ohio State University.

"Of Men and Molds" opened with a shot of Dr. Williams in a typical kitchen, where he pointed out use of castings in the sink, stove, utensils, etc. In response to questioning by Mr. Bell, Dr. Williams told how few items of everyday life could be produced without castings being used at sometime during their fabrication.

Next, Mr. Sanders molded and poured a decorative bookend, with Dr. Williams describing each operation in detail. Wood's metal was used for the demonstration.

While waiting for the casting to solidify, Dr. Williams briefly outlined the history of the metal castings industry, stating that Leonardo DaVinci, Benvenuto Cellini and seven signers of the Declaration of Independence were among many famous foundrymen. He added that the foundry industry is reputedly the largest basic industry.

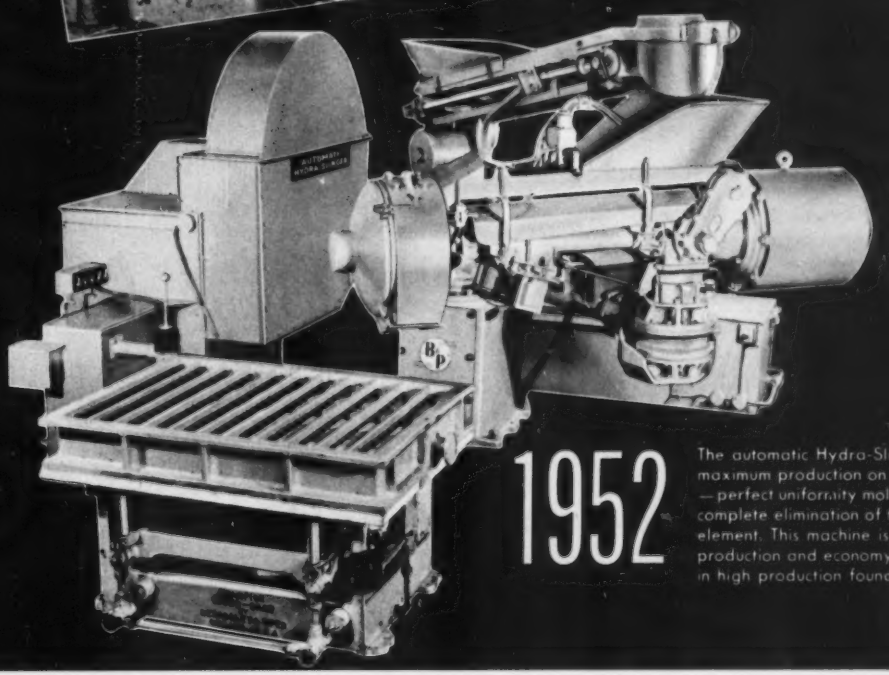
By this time the casting had cooled and as Mr. Sanders shook out the mold, finishing operations were described, then the completed casting was shown.

A.F.S. Central Ohio Chapter is the first of several foundry organizations who contemplate television programs to acquaint the public with the foundry and its place in the nation's economy. The NBC-TV network will shortly carry a film of operations at Albion Malleable Iron Co., Albion, Mich., and the A.F.S. Quad City Chapter plans a similar program.

(Left) Harry Sanders of Battelle Memorial Institute prepares to mold a bookend similar to the one held by D. C. Williams. (Right) Mr. Sanders pouring Wood's metal into mold during the television demonstration.

One of the very early "portable type" Sandslingers. It was moved by crane from job to job. Men shoveled sand from a heap into the rear of this slinger.

35 YEARS OF PROGRESS WITH THE FOUNDRY INDUSTRY!



The automatic Hydra-Slinger for maximum production on repetitive jobs—perfect uniformity mold after mold—complete elimination of the human element. This machine is setting new production and economy records in high production foundries.

In the 35 years since the first Sandslinger was placed in operation, thousands of Sandslingers, Swingslingers and Speedslingers have been installed in foundries the world over. These machines have revolutionized foundry molding practice!

A continuing program of research and development has resulted in improvement after improvement in slingers. Mobility, higher capacity, hydraulic control, automatic operation—each innovation foundry developed, foundry tested and foundry approved.

And in these past 35 years, Beardsley & Piper has introduced many other better methods. The Speedmullor and the Mulbaro have revolutionized sand mulling. Low cost sand preparation has been made possible with the Screenarator, the Nite-Gang, the Preparator and Combination Sand Conditioning and Mulling Units. In addition, many other B&P products—Plate Feeders, Turntables, Gyratory Screens and Roller Riddles—are helping to speed foundry operations.

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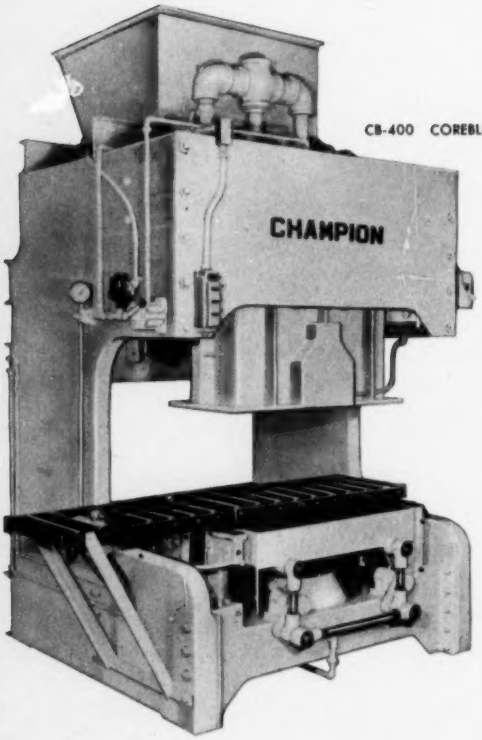

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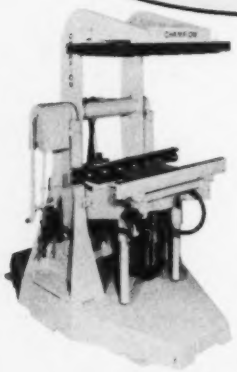

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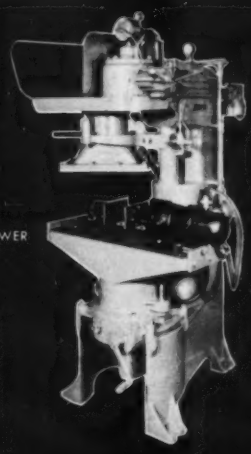

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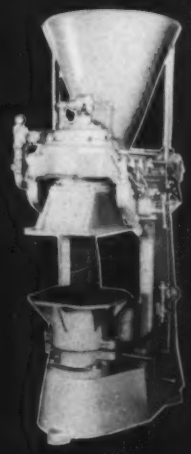

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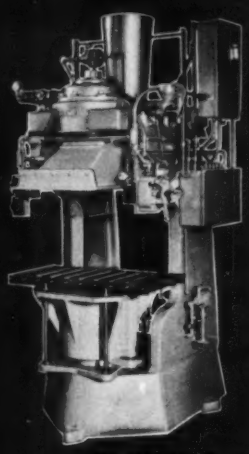
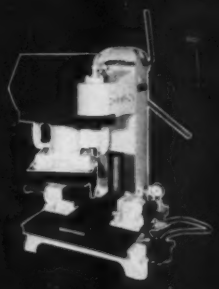


CB-15 *BLOMATIC* COREBLOWER



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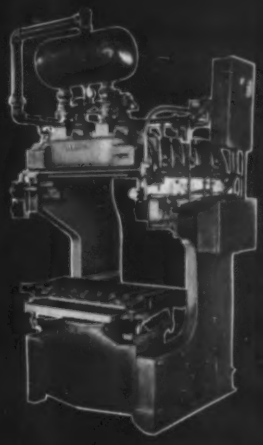

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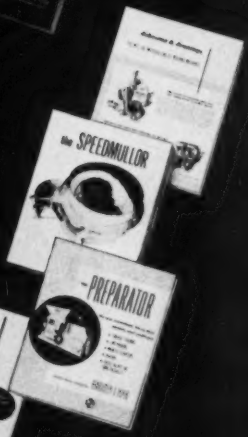

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A spiral test mold, modified to give a mean deviation of less than 2.0 per cent in duplicate tests, was used to determine the effects of temperature and metal composition on the fluidity of cast irons. Part of the tests were conducted to provide data on the effects of individual elements, and also on the interrelated effects of the components. From the test data a tentative formula was derived which makes possible the prediction of the relative effects of analysis variations and pouring temperatures on fluidity of the iron.

GRAY IRON FLUIDITY VARIABLES

effect of composition and pouring temperature

Lew F. Porter*
and
Philip C. Rosenthal*

Misruns, blows, and the necessity of pouring extremely thin sections are problems continuously present in the gray iron foundry. These problems are intimately related to the ability of the metal to fill a mold, and a study of the relative importance of the various factors affecting this property is obviously of interest to foundrymen. This ability of a metal to fill a mold is often referred to as "fluidity," and it is in this sense that the term will be used herein.

Another definition of the term fluidity is that it is the inverse of viscosity. This has led many foundrymen to the misconception that the variations which are found in the ability of various molten alloys to fill a mold are primarily dependent on the viscosity of the molten metal. Actually, a large number of factors are involved in determining the fluidity,[1] of which viscosity is of relatively minor importance.

Fluidity Factors Surveyed

Before investigating the effects of composition and pouring temperature on fluidity, a survey of all factors affecting fluidity and their probable relative importance is in order. The variables which influence fluidity may be divided into two major classifications: (1) factors related to the mold; and (2) factors dependent on the metal.

The factors related to the mold may be classified as follows: (1) static and velocity head; (2) size and shape of the mold; (3) composition of the mold; (4) mold temperature.

The effects and relative importance of these factors need not be considered here, but it can be seen that normal molding practice, in general, fixes those factors controlling fluidity that are related to the mold. Aside from these, there are those factors dependent on the metal which also can cause variations in the fluidity. The factors dependent on the metal are: (1) viscosity of the molten metal; (2) surface tension of the molten metal; (3) formation of surface oxide films; (4) formation of non-metallic inclusions in the molten metal; (5) degree of superheat (temperature above the start of freezing; (6) mechanism of freezing.

Investigation of the importance of these factors indicates it is unlikely that the probable variations in viscosity and surface tension would have any marked effect on the fluidity of cast iron. Under certain conditions surface oxide films and non-metallic inclusions could have a drastic effect, and these factors must be considered when abnormal or erratic results are obtained. Fluidity appears to be controlled primarily by the last two factors listed, and only these will be discussed in detail at this point.

The degree of superheat, i.e., the amount the alloy is heated above its liquidus temperature when poured, is an extremely important variable. This is not because of effects on viscosity so much as because superheat provides more time for flow. The metal is capable of

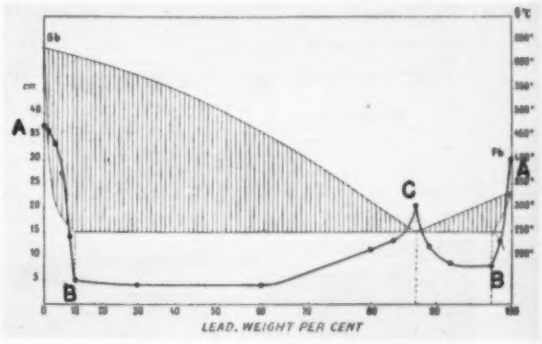
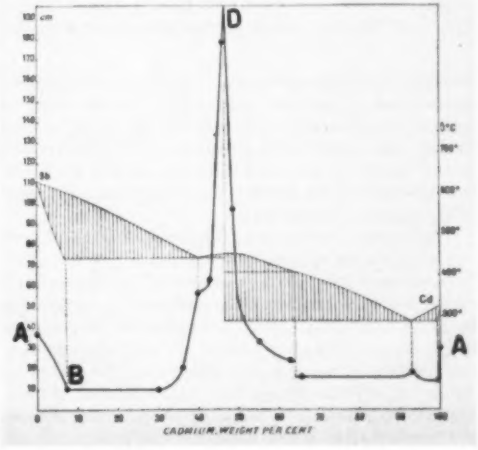
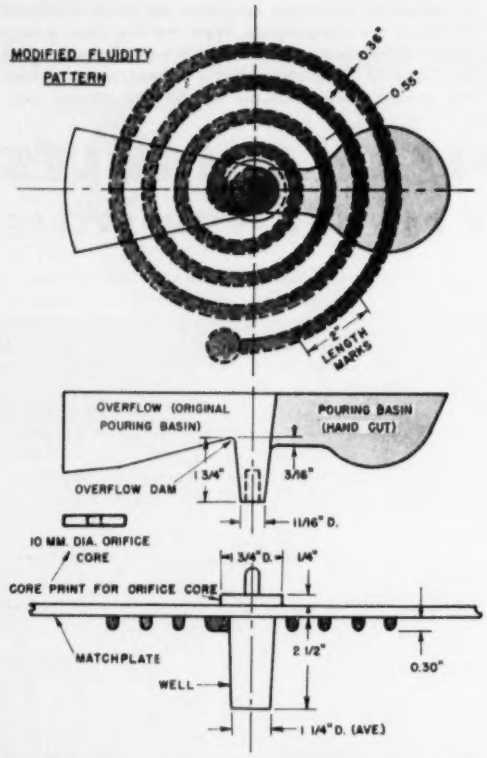
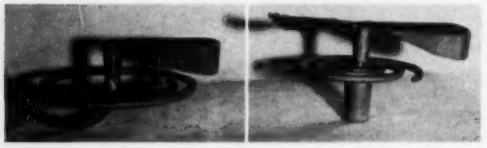


Fig. 1—The fluidity curves superimposed on the binary-phase diagrams indicate the close relationship between fluidity of the metal and the process of solidification.



*Research Engineer and Professor of Metallurgy, respectively, Department of Mining & Metallurgy, University of Wisconsin.





Figs. 2 and 3—Scale drawing of the modified fluidity pattern, and photographs of test castings poured in original Saeger and Krynitsky fluidity spiral (above, left), and fluidity spiral as modified (above, right).

flowing until freezing begins. The higher the pouring temperature above the temperature for the start of freezing, the longer it will take for the metal to cool to the point where freezing begins, and the higher will be the fluidity. Most of the work reported in the literature shows that the fluidity is a straight-line function of the degree of superheat.

The manner in which an alloy freezes has been found to have a major influence on the fluidity of the alloy. Portevin and Bastion[2] first presented the theory indicating the importance of the mechanism of freezing in 1932. They investigated a number of low-melting binary and ternary alloy systems and arrived at the conclusion that the major factor influencing the change in fluidity in any alloy system was the mechanism of freezing. The mechanism of freezing, in turn, was defined as a combination of two variables: (a) process of solidification (solidification range); (b) crystallization (crystal faces and speed of crystallization).

More specifically, the fluidity varies with the primary solidification range. The greater the solidification range, the lower is the fluidity. Therefore, maximum fluidity occurs when congruent (constant temperature) freezing takes place such as in the case of pure metals and alloys of eutectic composition. Minimum fluidity occurs at the maximum limits of solid solubility. This is true whether tests are made using a constant degree of superheat above the liquidus or a constant pouring temperature.

With regard to the mode of crystallization, when polyhedral crystals are the first to form fluidity is better than when dendritic crystals are the first to separate. The dendritic type of freezing occurs in ferrous alloys.

The generalizations concerning the effect of alloy systems on fluidity are nicely illustrated in Fig. 1, in which the variations in fluidity are plotted on the binary-phase diagrams for the systems animony-lead and antimony-cadmium.

Points "A" show the relatively high fluidity of the pure metals as compared with the alloys; points "B" show the minimum fluidity which occurs at the limit of solid solubility; point "C" shows the high fluidity which occurs at eutectic alloy compositions; and point "D" shows the extremely sharp maximum which occurs under the favorable polyhedral mode of solidification of the intermetallic compound SbCd. If some simplifying assumptions are made, cast iron can be assumed to have a freezing mechanism similar to that between points "B" and "C" of the top diagram, Fig. 1.

With this brief survey of factors affecting fluidity, it is felt that the specific problem of gray cast iron fluidity as affected by composition and temperature variations will be more clearly defined.

Procedure and Results

Fluidity Test Mold: In order to study the effects of composition and temperature a fluidity test is necessary which will maintain the factors related to the mold essentially constant, while producing a sensitive measure of the variations in fluidity due to variations in the metal. A number of such fluidity tests have been devised. The most popular test is to pour the metal into a mold having a spiral channel of small cross-sectional area. The spiral is long enough to extract sufficient heat to cause solidification of the metal before it reaches the end of the channel. Thus, the length of the metal spiral obtained is a measure of the fluidity.

Such a fluidity spiral designed by Saeger and Krynitsky[3] of the Bureau of Standards is in general use, and therefore was adopted for preliminary investigation. The pattern was molded in a naturally bonded green sand containing 6 per cent moisture since green sand is normally used in pouring gray cast iron.

Four 16-lb induction furnace heats of a standard gray iron composition were made. Two Saeger fluidity spirals were poured from each heat. Although each spiral was poured with metal of the same composition and from the same temperature, the spiral lengths varied from 29 to 35 in. This is a deviation of 9.4 per cent from the mean and was not of sufficient accuracy for the contemplated program.

Observations made during the test indicated that it

was difficult to maintain a steady flow of metal and a constant metal head. It will be remembered from the introduction that this is one of the factors related to the mold which can affect fluidity. Berger and Perin[4] did work on the fluidity of cast iron in 1934. They used a different gating system than that proposed by Saeger and Krynitsky, and claimed a reproducibility of 1 per cent deviation from the mean. Accordingly, the Saeger and Krynitsky pattern was altered so that the gating system agreed more closely to that of Berger and Perin.

Figure 2 is a drawing of the altered pattern, and Fig. 3 photographs of the fluidity test castings poured using the original and the altered patterns.

Changes made in the original pattern consisted of substituting a well and orifice core for the horn gate and providing a means of maintaining a constant level of metal head through use of an overflow basin. In theory the first metal into the mold begins to fill the well. This allows time to fill the pouring basin and downspout to the height of the overflow dam before the metal enters the spiral. Thus as the well fills and the metal begins to flow into the spiral the rate of metal flow is controlled by the constant head and the size of the orifice core.

It should be noted that the connection between pouring basin and sprue is about $\frac{3}{16}$-in. lower than the overflow dam. This is to assure a constant head of metal once the pouring basin and well have been filled with metal.

Tests performed using the altered fluidity mold proved this method to be much more consistent. Considering all tests that have been made to date it appears that a mean deviation of approximately 2.0 per cent is obtained.

Fluidity Variations With Carbon and Temperature

The experimental work on the effect of composition and temperature on the fluidity of gray cast iron was divided into two major phases. The first phase determined the variation in fluidity of a high-phosphorus, high-silicon cast iron with carbon content and temperature. In the second phase, a "factorial" experiment was designed to show the main and interrelated influence of carbon, manganese, silicon, and phosphorus on the fluidity of cast iron.

The base metal used in the study had the following composition: Total carbon, 3.1 per cent; Mn, 0.30; Si, 2.4; P, 0.80; S, 0.10. Standard procedure consisted of melting a constant weight of the base metal scrap in an induction furnace, adjusting the carbon content to the desired value, then regulating to the desired temperature using a platinum-platinum 10 per cent rhodium thermocouple in a silica protection tube immersed $2\frac{1}{2}$ in. into the melt. When the melt was stabilized at the desired pouring temperature, the couple was removed, the power turned off, and the fluidity mold poured as quickly as possible.

The first variable to be studied was the effect of carbon on the fluidity of the base iron poured at 2600F. To do this it was necessary to change the carbon content of the iron without changing the rest of the analysis. For carbon contents higher than the normal content of the scrap, this was accomplished by adding powdered graphite to the melt. It was necessary to superheat the metal to approximately 2800F to effect rapid solution of the graphite. Once in solution the temperature was lowered to 2600F and the fluidity mold was poured.

For carbon contents below that of the normal content of the scrap a somewhat unusual method was used. Related work in the department laboratories has shown that holding the melt at high temperatures caused the carbon to drop while the rest of the analysis remained practically unchanged. Furthermore, it is possible to gage the holding time necessary to lower the carbon any given amount. Figure 4 is a graph of the effect of holding time at 2700F on the carbon and silicon contents of the scrap iron used when melted under an atmosphere of air in a magnesia crucible.

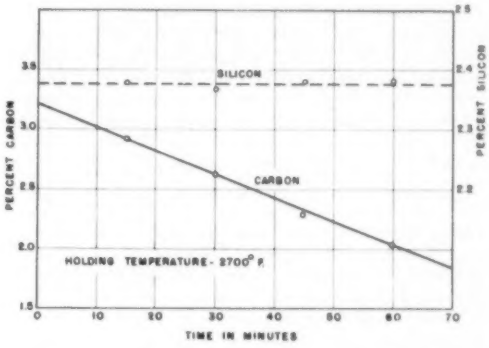


Fig. 4—Graph showing effect of holding time at 2700F on the carbon and silicon contents of gray cast iron.

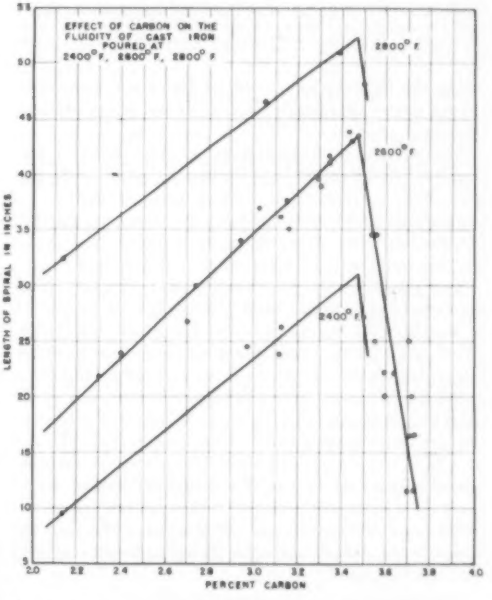


Fig. 5—Curves showing effect of carbon contents on fluidity of cast irons at various pouring temperatures.

TABLE 1—COMPOSITION, FLUIDITY, AND LIQUIDUS TEMPERATURES OF IRONS USED IN FACTORIAL EXPERIMENTS

Symbol	Composition, % C	Mn	Si	P	Fluidity, in.	Liquidus Temp., F
I	2.0	0.3	1.0	0.18	21 1/4	2442
					21	2447
C	3.1	0.3	1.0	0.18	24 3/4	2210
					24 3/4	2210
Mn	2.0	1.5	1.0	0.18	18 3/4	2450
					20	2470
Si	2.0	0.3	2.4	0.18	21 3/4	2422
					21 1/2	2422
P	2.0	0.3	1.0	1.18	22 1/4	2370
					22 1/4	2372
C Mn	3.1	1.5	1.0	0.18	24	2215
					23 1/2	2190
C Si	3.1	0.3	2.4	0.18	27	2128
					25 3/4	2181
CP	3.1	0.3	1.0	1.18	26 1/2	2110
					26 1/2	2112
Mn Si	2.0	1.5	2.4	0.18	18 1/2	2400
					19 3/4	2400
Mn P	2.0	1.5	1.0	1.18	20 1/2	2357
					19 1/4	2356
Si P	2.0	0.3	2.4	1.18	25	2322
					25 1/2	2317
C Mn Si	3.1	1.5	2.4	0.18	23 1/4	2230
					23 3/4	2178
Mn Si P	2.0	1.5	2.4	1.18	22 1/4	2305
					22	2312
C Si P	3.1	0.3	2.4	1.18	27 1/4	2050
					28 1/2	2035
C Mn P	3.1	1.5	1.0	1.18	24 1/2	2122
					24 1/4	2150
C Mn Si P	3.1	1.5	2.4	1.18	28	2022
					28 1/2	2065

Spot check analyses were made for each of the elements after their addition in the amounts indicated in the text. The values given above represent the average of these determinations.

Using the information shown in Fig. 4 it was a simple matter to reduce carbon content to any given value in the range studied.

The effect of varying carbon on the fluidity of gray iron poured at 2600F was studied by pouring 30 separate fluidity tests. The carbon content was varied from about 2.2 to about 3.7 per cent. Next the effect of temperature was determined by pouring low, intermediate and high-carbon irons at 2400 and 2800F.

The results of the tests are shown in Fig. 5, where the carbon content has been plotted against the length of the fluidity spiral. Curves are given for 2400F, 2600F and 2800F. The point of inflection was definitely established at 3.48 per cent carbon for the curve at 2600F. Theoretically, this point corresponds to the eutectic composition of the iron. While this point was not definitely established for the curves at 2400F and 2800F, it should occur at the same carbon content. One test heat having a carbon content in excess of 3.48 per cent did show a reduced fluidity when poured at 2400F and 2800F. It was on this basis that all the curves were drawn with the sharp inflection at 3.48 per cent carbon.

The following points are of interest:

(1) Carbon has a great effect on the fluidity of this iron. Between the limits tested from 2.2 per cent carbon to the eutectic composition, fluidity is a straight-line function of carbon content.

(2) The eutectic composition has the highest fluidity, but once the eutectic is passed fluidity falls with disastrous rapidity. It was noted that in the hypereutectic compositions, graphite separated out of the liquid melt as cooling began. The drastic drop in fluidity is believed due to the formation of kish which, because of its flake-like nature, is very detrimental to the flow of the metal. This agrees with the principles laid down by Portevin and Bastien.

(3) Temperature has an important effect on fluidity. In general, an increase of 200F results in a fluidity increase of 10 to 11 in.

Variable Effects Determined by Factorial Experiment

The "factorial" experimental design[5] is of special interest in research investigations of a large number of variables since it yields the maximum amount of reliable useful information for the least expense. In this study the effect of the variables carbon, manganese, silicon and phosphorus on the fluidity of hypo-eutectic cast iron was determined. In order to minimize the number of tests necessary only two levels of each of the variables were decided upon.

Specifically, this experiment determined the effect of increasing the carbon from a level of 2.0 to 3.1 per cent; manganese from 0.3 to 1.5 per cent; silicon from 1.0 to 2.4 per cent; and phosphorus from 0.18 to 1.18 per cent. When all of the variables are at a low level an initial composition is obtained from which all of the remaining compositions can be produced by adding the proper amounts of the specific elements. The initial composition was that of a large supply of uniform malleable iron scrap.

The symbol "I" will be used to denote this initial composition. The symbols C, Mn, Si, and P denote carbon, manganese, silicon, and phosphorus, respectively. Whenever a composition contains the higher value of a particular element, the symbol for the element appears in the symbol for the composition. All possible combinations of the two levels of each of the four variables were included in the experiment.* Furthermore, each composition was tested in duplicate. The symbols and the compositions they represent are given in the first five columns of Table 1.

All other probable variables were held as constant as possible. The variable of pouring temperature was particularly important in this study because it determines the degree of superheat (i.e., temperature above the start of freezing). As the composition of the iron changes the temperature at which the alloy begins to freeze changes. Therefore, to separate superheating effects from the actual effects of the composition in fluidity, each composition was poured from the same temperature interval above the point at which that composition started to freeze.

The start of freezing was determined by recording the temperature of the molten alloy while it was being slowly cooled. This was done by using a platinum-

*If a low-carbon iron is made with a low- and high-silicon content, and if a high-carbon iron is also made with a low- and a high-silicon content, $2 \times 2 = 4$ heats will be required. For four elements, each at two composition levels, there will be $2 \times 2 \times 2 \times 2 = 16$ heats.

platinum 10 per cent rhodium thermocouple in conjunction with a General Electric photoelectric potentiometer recorder. An abrupt change occurred in the cooling curve slope when the alloy started to freeze.

A standard melting practice was used in making the various compositions. The melting procedure followed was to charge 8 lb total scrap having the initial (I) composition to which was added alloying elements to make the composition desired.

The alloys and quantities used for the additions were: Mn, 71 grams 80 per cent ferromanganese; Si, 105 grams 50 per cent ferrosilicon; P, 167 grams 25 per cent ferrophosphorus; C, 50 grams of graphite.

Except for the graphite, all alloy additions were placed in the bottom of the induction furnace under the scrap addition. Graphite was added to the clean surface of the molten iron after the melt had reached a temperature of 2600F. It usually took about 15 min for the graphite addition to go into solution, at which time the metal temperature had reached about 2800F. After all additions had gone into solution, the power was turned off and a recording made of the cooling curve. When the break in the cooling curve indicated the start of freezing, the power was again applied until 350F superheat was reached. This temperature was maintained long enough to guarantee constancy, and the fluidity casting was then poured.

The fluidity and liquids temperatures obtained for each composition are listed in Table 1. The usual method of analyzing such data in a factorial experiment is through a system of mathematical formulas whereby it is possible to determine the main effect of each variable being studied and all interrelated effects.

For instance, to determine the main effect of carbon on the fluidity find the average fluidity of all of the heats which contain carbon at the high level and subtract from this the average fluidity of all of the heats which contain carbon at the low level. The excess of the first average over the second will be the main effect of carbon.

Arrange Mathematical Relationships

In a similar manner the main effect of manganese, silicon and phosphorus can also be determined. By proper rearrangement of the mathematical relationships, so-called first, second, and third-order interactions can be determined. In a first-order interaction we might determine such effects as the influence of increasing the phosphorus content on the effect of carbon. In a second-order interaction we might determine the influence of increasing the phosphorus content on the influence of silicon on the effect of carbon.

A third-order interaction would determine the influence of phosphorus on the influence of silicon on the influence of manganese on the effect of carbon. Furthermore, it is found that rearranging the order of variable does not affect the results. Thus, the influence of increasing carbon content on the effect of phosphorus is the same as the influence of increasing phosphorus content on the effect of carbon. In this experiment there are four main effects, six first-order, three second-order, and one third-order interactions. The results of mathematical analysis of this data are shown in Table 2.

It is seen that the values of all interactions except that between silicon and phosphorus fall within ± 0.5 in. of fluidity. The range of ± 0.5 in. is probably within the limits of experimental error and, therefore, it may be assumed that except for phosphorus and

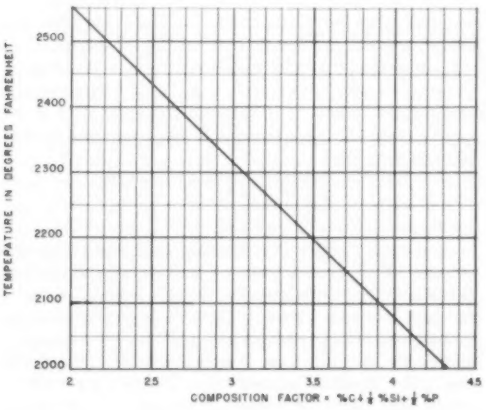


Fig. 7 (above)—Applying the fluidity formula, relationship between cast iron composition and the liquidus temperature may be plotted.

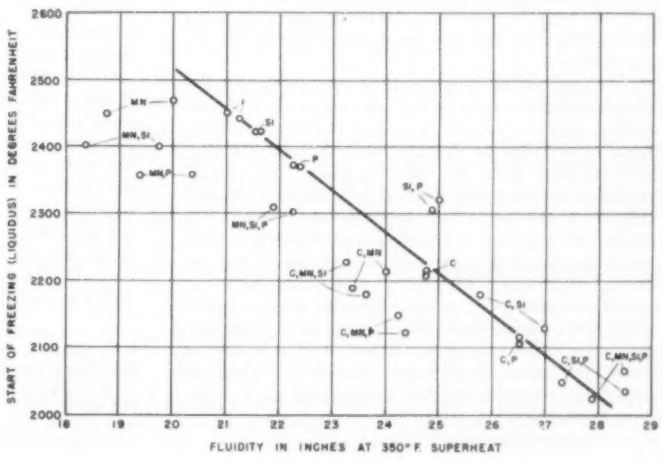


Fig. 6 (right)—Graph showing the relationship between liquidus temperature and fluidity of various composition gray cast irons at superheat temperature of 350°F.

silicon no interactions exist, and that the main effects of the four elements studied are additive and not dependent on what other elements are present.

Furthermore, when the results are confined strictly to hypo-eutectic cast irons, previous experiments as well as results reported in the literature indicate that the main effect of each of the elements on fluidity varies linearly with the amount of the element present. Thus it is concluded that for a one per cent increase in each element, carbon increases fluidity of the iron approx. 4 in., silicon increases fluidity approx. 1 in., phosphorus increases fluidity approx. 2 in., and manganese decreases fluidity approx. 1.5 in.

It was found that the data obtained in the factorial experiment can be analyzed in another manner. A plot of the temperature for the start of freezing against the fluidity of the various compositions gave the results shown in Fig. 6.

This graph shows that, in general, fluidity is inversely proportional to the start of freezing temperature with two exceptions. First, increasing the manganese content causes a somewhat erratic decrease in fluidity without a corresponding change in the start of freezing temperature. The decrease in fluidity is not so apparent in the gray cast iron range as in the malleable iron range of composition. Second, the combination of the high level of silicon and phosphorus in a composition low in carbon appears to have a unique first-order interaction which results in a fluidity greater than the additive effects of the individual elements and greater than the corresponding change in the temperature for the start of freezing. This point was checked with two additional heats and the results were verified.

TABLE 2—EXPERIMENTAL DATA ANALYSIS RESULTS

Components	Fluidity, in.	Components	Fluidity, in.
MAIN EFFECTS			
Carbon	+4.3	Silicon	+1.5
Manganese	−1.9	Phosphorus	+2.0
FIRST-ORDER INTERACTIONS			
Manganese & Carbon	+0.4	Phosphorus & Manganese	+0.1
Phosphorus & Carbon	−0.5	Silicon & Manganese	0.0
Silicon & Carbon	+0.2	Phosphorus & Silicon	+1.0
SECOND-ORDER INTERACTIONS			
Silicon, Manganese & Carbon			+0.2
Phosphorus, Manganese & Carbon			+0.4
Phosphorus, Silicon & Carbon			−0.2
THIRD-ORDER INTERACTIONS			
Carbon, Silicon, Phosphorus & Manganese			+0.5

The graph in Fig. 6 supports the contention that the freezing mechanism is one of the major factors controlling fluidity. In the case of manganese an additional factor may be exerting an influence. Manganese sulphide particles forming under the proper condition could be responsible for the drop in fluidity without a change in the liquidus temperature. If manganese sulphide particles are responsible, an increase in the sulphur content should also affect the fluidity adversely. Therefore, additional tests are planned in which the sulphur content will be varied.

The inconsistent first-order interaction between silicon and phosphorus when carbon is low is not so readily understood. Fortunately, this effect is of minor importance since the combination of high silicon and phosphorus with low carbon does not appear to be of great commercial importance.

The information obtained from the experimental work suggests a general formula for the variation in fluidity with composition and temperature which makes it possible to determine the relative fluidity of any set of hypo-eutectic cast irons poured from any temperature.

The first portion of the work dealing with the effects of carbon and temperature shows that fluidity increases an average of about 5 in. per 100F increase in temperature. With this information in conjunction with that obtained from the factorial experiment a formula for determining fluidity is derived:

$$\text{Fluidity, inches} = 4C + 1Si + 2P + \frac{5 \text{ degrees superheat}}{100}$$

where the content of each element is given in percentages. The effects of manganese have been omitted because of the erratic and relatively small influence it has exhibited.

In applying this formula, results of calculated fluidity are consistently 6 in. above the experimentally determined fluidity. This is due to the fact that the formula given does not make allowance for a base fluidity value which is independent both of composition and degree of superheat. The factor 6 in. can be considered a base correction value. The fact that it is negative may be due to the difference between the temperature of the metal in the induction furnace and the temperature of the metal as it enters the fluidity spiral. In other words, the 6 in. may represent the amount the metal cools between the furnace and the mold. With the base correction the complete fluidity formula becomes:

$$\text{Fluidity, inches} = 4C + 1Si + 2P + \frac{5 \text{ superheat in } °F}{100} - 6$$

In order to apply this formula to a given iron the amount of superheat must be known. To determine the amount of superheat the liquidus temperature of the iron must be known. Figure 6 indicates that the carbon, silicon and phosphorus are the elements which determine the liquidus temperature, and that they affect the liquidus temperature in the same way in which they affect the fluidity of the metal. Therefore, the temperature for the start of freezing is inversely proportional to the value of $C + \frac{1}{4}Si + \frac{1}{2}P$, and can be plotted as shown in Fig. 7.*

Using the fluidity formula in conjunction with Fig. 7, it is possible to calculate the fluidity of any hypo-eutectic cast iron. The calculated fluidity will not be experimentally reproducible unless conditions of pouring, melting and molding are the same as those used in the laboratory experiment. However, the results of a calculation for one composition would appear to be comparable with the results for another composition under a given set of conditions, and thus will give an indication of the relative fluidity effects of composition and temperature.

* A commonly used criterion for determining eutecticity is $C + \frac{1}{3}(Si + P)$, and this equation gives a value which shows approximately how close the iron is to eutectic composition, a value of 4.3 usually being assumed for that point. The equation used in the present case is intended to give an expression for the liquidus line, and was established from data relating liquidus temperature with composition and fluidity.

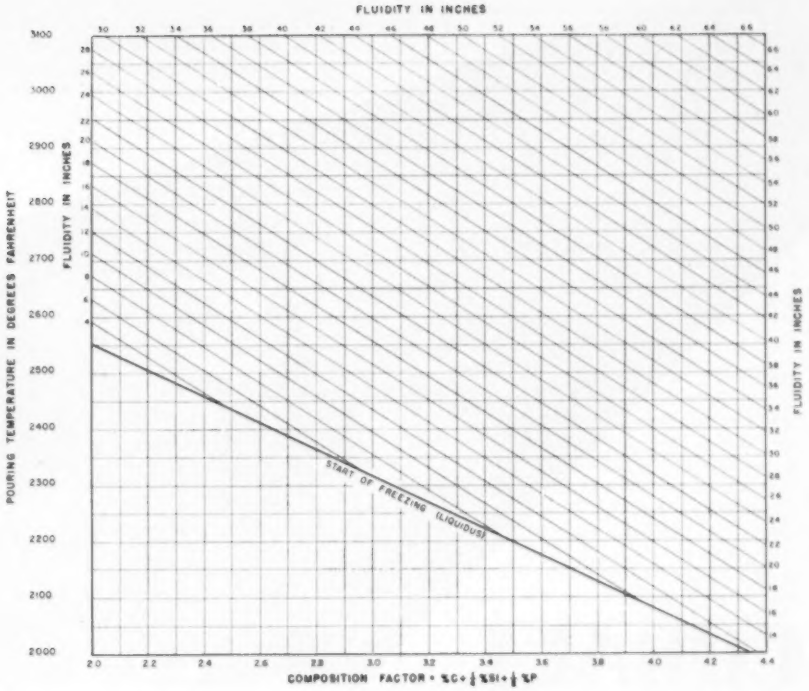

FLUIDITY IN INCHES
POURING TEMPERATURE IN DEGREES FAHRENHEIT
FLUIDITY IN INCHES
START OF FREEZING (LIQUIDUS)
COMPOSITION FACTOR = %C + ¼ %Si + ½ %P
FLUIDITY IN INCHES

Fig. 8—The relative fluidity of hypoeutectic cast iron can be read directly from a chart constructed by plotting the pouring temperature against the iron composition.

In most commercial cast irons the manganese content is in the range of 0.3 to 0.5 per cent, and the sulphur content is normally about 0.1 per cent. These elements therefore exert a fairly constant effect on the fluidity. By neglecting the effect of the Si-P combination, and holding the manganese and sulphur constant at the above mentioned levels, it is possible to construct a chart whereby one can read directly the fluidity of any hypo-eutectic cast iron, knowing the pouring temperature and the carbon, silicon, and phosphorus contents of the iron.

The chart (Fig. 8) will not be as accurate as the empirical formula because of the assumptions noted above, but it more than makes up in simplicity what it lacks in accuracy. Again it should be pointed out that the chart will only give an indication of the relative fluidity of irons of different compositions and pouring temperatures. For instance, a change in fluidity from, say, 20 to 40 in., does not mean that fluidity is doubled, but merely that it is increased as measured by the fluidity spiral.

Conclusions

(1) It has been shown that normally the mechanism of freezing determines the effect of composition on the fluidity. There are indications that under certain conditions other factors such as the formation of nonmetallic inclusions in the melt can markedly alter the fluidity of the metal.

(2) Carbon has the greatest influence on increasing fluidity of hypo-eutectic cast iron. Phosphorus is half as effective as carbon, and silicon one fourth as effective as carbon.

(3) Manganese reduces the fluidity of cast iron for hypo-eutectic compositions, but has little or no effect near the eutectic.

(4) The fluidity increases rapidly and in a straight-line function as the degree of superheat is increased. Thus, pouring temperature is an important factor in controlling fluidity.

(5) A formula and chart relating the effects of composition and temperature to fluidity has been proposed.

(6) No attempt has been made to assess the effects of sulphur or of melting conditions on fluidity. This is to be the objective of additional work in this field.

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Cupola Research Reports Available

JUST PUBLISHED by American Foundrymen's Society is CUPOLA RESEARCH COMMITTEE REPORTS. Originally published in AMERICAN FOUNDRYMAN, the reports cover the findings of several years' research into various phases of cupola operation. Copies are available from A.F.S. Headquarters, 616 S. Michigan, Chicago 5, at $1.00 to members and $1.50 to non-members.

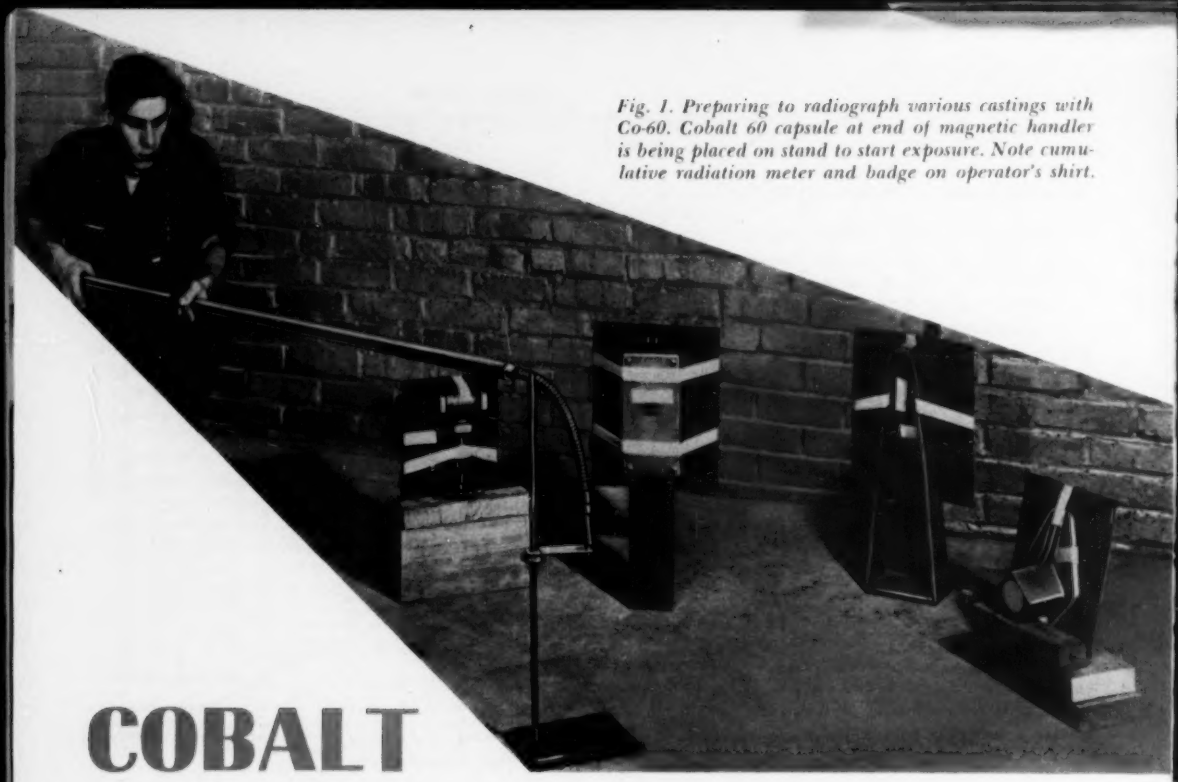

Fig. 1. Preparing to radiograph various castings with Co-60. Cobalt 60 capsule at end of magnetic handler is being placed on stand to start exposure. Note cumulative radiation meter and badge on operator's shirt.

COBALT 60 in the Foundry

Availability of high specific activity Cobalt-60 provides a readily portable source of high energy gamma rays, giving the foundryman an extremely useful tool for radiography. Its relative inexpensiveness brings radiography within reach of smaller organizations.

John C. Pennock
Assistant Chief Engineer
Tracerlab, Inc.
Boston, Mass.

RADIOACTIVE SUBSTANCES for industrial radiography should have: (1) long half-life, (2) gamma rays of desired intensity, (3) high specific activity, and (4) low cost. Cobalt-60 meets these requirements. It can be used for detecting internal defects in castings of all types of alloys.

Cobalt-60 is produced by placing a piece of plain cobalt (Co-59) in a controlled nuclear reactor, which "propels" neutrons into the nucleus of the Co-59 atom. These extra neutrons unbalance the cobalt atom, transforming it into Co-60. The unstable Co-60 gradually breaks down into nickel, emitting gamma rays in the process.

It is these gamma rays that give Co-60 its usefulness. Similar rays give x-ray machines and radium their usefulness, and in the same way—by passing through material and affecting film in proportion to the amount of unabsorbed radiation. All else being equal, penetration is greater the shorter the wave length of the rays.

Radium (in equilibrium with its products) gives off a series of wave lengths of varying intensities approximating in penetrating power the radiation from a 2-million volt x-ray machine. Cobalt-60, however, gives off gamma rays of essentially two wave lengths, corresponding very closely to the most intense radiation from the 2-million volt x-ray machine.

In the range of steel thicknesses between ¾ and 6 in., Co-60, radium, and x-rays give essentially the same type of radiograph. Below this range, Co-60 radiographs have a little less contrast than those made with radium or 2-million volt x-rays; above 6 in. Co-60 has less penetrating power. Actual difference in quality of radiographs made outside the ¾ to 6 in. range with Co-60 and with radium is not great, and use of Co-60 is not limited to this range.

Specific activity is essentially the number of gamma rays emitted per unit volume, or mass. The higher the specific activity, the smaller the source can be. A smaller source gives better definition to the radiograph—less blurring of the edge of a flaw by gamma rays coming from different points of the source. This is illustrated in Fig. 2. The Co-60 now available has a specific activity about 10 times that of conventional radium sources. This means that for a given amount of radia-

NOTE: This paper was presented at the 1951 Metals Castings Conference, Purdue University, Lafayette, Ind.

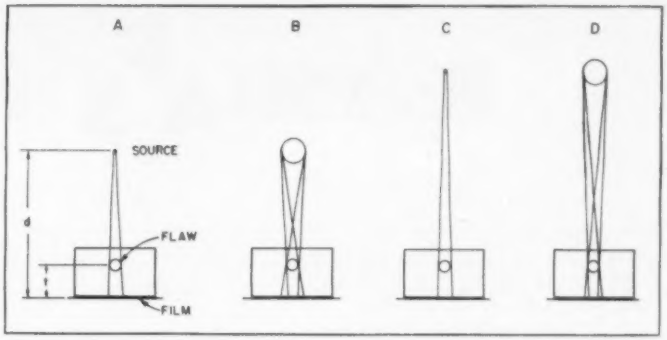

Fig. 2. Effect of source size and distance from flaw and film. Edges of flaw are less sharp with larger source, or with source located closer to film.

tion the cobalt source can be slightly under half the diameter of a radium source. Either of two advantages is offered: a smaller source can be used to obtain better definition, or a source of the same size can be used to cut exposure time to $\frac{1}{10}$.

Cobalt-60 is roughly 1.6 times as strong as radium, but because rays from the two materials are absorbed differently by the material being radiographed, separate exposure charts are used.

The half-life of Co-60 is 5.3 years (Fig. 3). Starting with a given amount, one-half will remain in 5.3 years. Half of that amount will decay during the next 5.3 years, and so on. Theoretically, some Co-60 will always remain, but it gets progressively weaker so that in 16 years the exposure time will be eight times as long.

The equipment required for taking radiographs with Co-60 is quite simple and the same as is used for radium. In general, all that is needed is a source in its sealed container, a shipping and storage container, and a handling device, plus the standard film apparatus common to all radiography.

The source is contained in a hermetically sealed capsule which prevents the spread of the Co-60. The shipping and storage container, a steel shell filled with lead, serves to block radiation, which is dangerous to personnel if sufficiently absorbed by the body. Since Co-60 cannot be picked up in the hands without injury, the handling device serves in placing and moving the source. A very convenient method—safer than the customary string attached to the source—is to use a magnetic type of handler. This is shown in Fig. 1.

However, some radiation will be absorbed by the operator. To warn him of excessive exposure, several safety devices should be employed. One is a radiation survey meter. Commonly called Cutie Pie from its wartime code name, the instrument tells the rate at which radiation is being received at any given locality. It can be used to survey large castings for gross internal defects and may thus save time by limiting the number of radiographs required. To do this the source is placed on one side of the casting while the Cutie Pie is used to measure unabsorbed radiation on the other side.

Another safeguard is a cumulative survey meter, about the size of a fountain pen, which registers the total amount of radiation received in a given period.

A third, the film badge serving the same purpose, consists of a clip holding several strips of x-ray film and a calibration device. It too indicates when the wearer is approaching the tolerance limit of radiation and provides a permanent record of the amount.

Techniques of using Co-60 are simple. In Fig. 1 the operator is using an ordinary laboratory ring stand to support the source.

Identical castings can be placed in a circle all around the source. If a variety of castings are being radiographed, they can be positioned at varying distances (the thicker, the closer) so that exposure time for all will be the same. Or the source can be placed inside large castings to give simultaneous radiographs of a number of areas in a single casting.

An operator is not needed during the exposure, as Co-60 requires no attention and has no controls. Overnight exposures are not only possible but practical. As the radiographer gains experience in the use of Co-60, his own originality will show him how to make safe and efficient devices to meet specific problems.

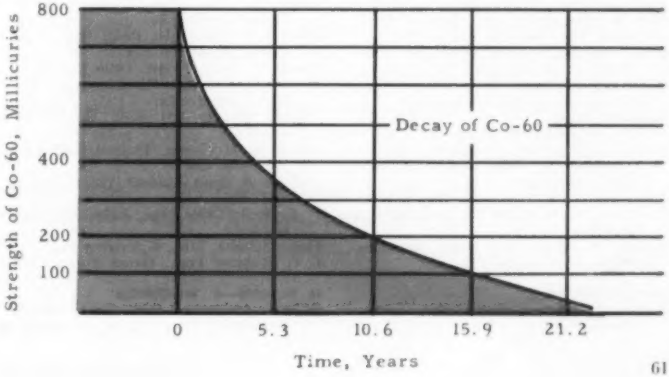

Fig. 3. Decay curve is exponential. Cobalt 60 will decay to half its original strength in 5.3 years, to one-fourth its original strength in 10.6 years, but will never lose all of it.

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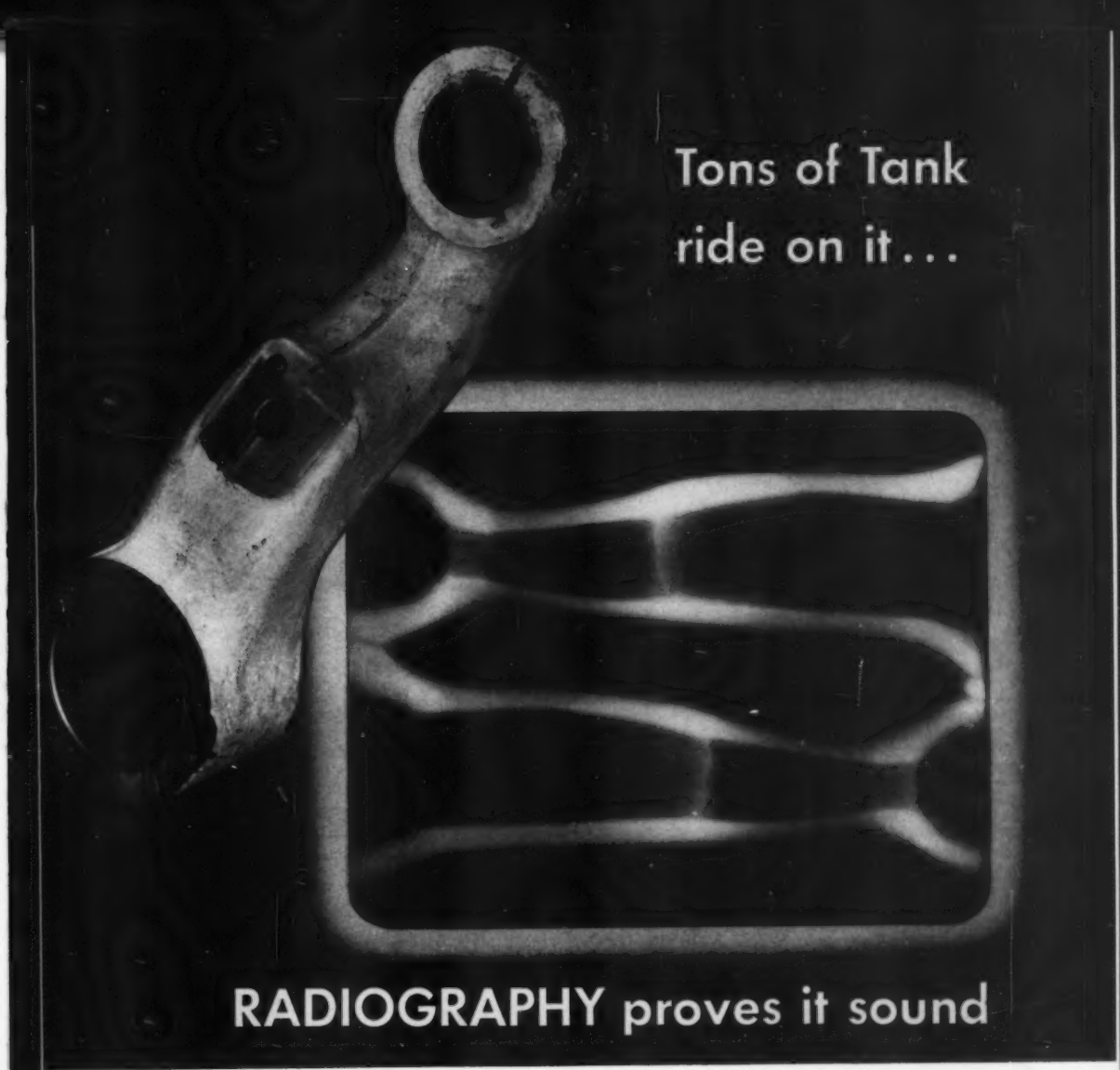
(Continued on page 96)



It's the arm that carries the rear caterpillar track wheel of a tank. Failure would mean complete disablement—so soundness in the casting is a "must."

To make sure, the casting is radiographed. It's the one way to learn internal conditions without destroying the part.

Cases like this show why radiography is becoming routine in foundries everywhere. It helps earn a reputation for constant top-quality work—frequently suggests changes in operations that bring higher yields in production runs.

Your x-ray dealer will be glad to discuss ways radiography can increase your production. Get in touch with him. Also send for a free copy of "Radiography As A Foundry Tool."

EASTMAN KODAK COMPANY
X-ray Division, Rochester 4, N. Y.

Radiography...

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GERMAN FOUNDERS' 42nd GENERAL MEETING

APPROXIMATELY 1500 engineers, technicians, and foundrymen met on September 27-28-29 in Dusseldorf, Germany, for their annual meeting and the 42nd general congress of the Verein Deutscher Giessereifachleute. Surpassing previous estimates, this crowd was barely accommodated by the facilities provided.

Many Foreigners Attend

The importance of the German foundry industry was marked by the attention given the meeting from abroad; altogether, 85 representatives from Belgium, Chile, Denmark, England, France, Italy, Holland, Norway, Austria, Sweden, Switzerland, and the United States attended, according to Dr. E. Hugo, secretary of the society.

J. H. Kuster, society president, pointed out in his speech of welcome that the society has developed greatly since its refounding in 1947.

Dr. Hugo then delivered an address on the future tasks of the VDG. One task stressed was the need for improving public relations.

Dr. M. Weller discussed *"The Engineer and the Spoken Word,"* after which L. Brandt mentioned several future tasks of the German engineer.

The technical program was well balanced and well received. Topics consisted of the following:

American Film Shown

An American film, *"New Methods in Sand Treatment."* This treatment consists of horizontal, eccentrically supported discs moving freely inside a bin; centrifugal force reduces lumps of sand and mixes sand and binders as the rubber-lined discs rotate against the rubber lining of the bin.

"Working with Synthetic Molding Sand," H. Herschnz, Frankfurt M. Hochst. German chemical industry has developed ways to treat sands chemically to obtain the quality of natural American bentonite.

"New Results with the Cement Molding Process," M. Beilhack, Rosenheim. The paper told how to avoid various disadvantages of the process, including long period of drying, low green strength, and high amounts of cement and bonding agents.

"Sand Treatment for the Cement Molding Process," H. Gries, Braunschweig. This paper covered the essential points of disintegration of waste sand, efficient dust collecting, and the return of quartz sand to the process.

Cites Fatigue Limit Possibilities

"On the Rated Fatigue Limit of Malleable Cast Iron," E. Mickel, Stuttgart-Bad Cannstatt. After pointing out that this limit lies between steel and gray cast iron, the paper offered suggestions for making full use of the possibilities of the fatigue limit.

Evaluating Metal Stresses

"Application of the Wire Resistance Strain Gage for Cast Constructions," K. Fink, Dusseldorf. Although the analysis of stresses in steel parts is comparatively simple, the evaluation of stresses in cast iron parts is difficult due to the influence of the modulus of elasticity as a function of the stress, and of the positive and negative sign of the tension of compression. Research is gradually improving the elastic properties of cast iron so that it is now similar to normal steel.

The American Foundrymen's Society film, *"Principles of Gating,"* with an introduction by P. Schneider, Hamburg. The film showed tests run with transparent models of gates; aluminum flakes in an emulsion of water and Wood's metal were used as test liquids. Tapered sprues showed the best results.

"On Modern Core Drying Methods," W. Magers, Dusseldorf. A recital of methods, mostly American, showed which ways could be followed under specific circumstances. High frequency heating of nonmetals and cores were of primary interest.

Lost-Wax Process Described

"The Practice of Wax Extraction in a Molten Condition," H. Heimann, Kaiserslautern. It was explained that the lost wax process is especially useful in making high-speed cutting tools. The mold can be made to very accurate dimensions so that the tool requires nothing but subsequent hardening and grinding. The saving of material is particularly important for expensive steels. Economy does not so much depend on the number of castings as on the number of machining operations and the required accuracy.

"Heat-Developing Gates," E. Lanzendorfer, Mulheim/Ruhr. Runners and risers to avoid shrink-holes waste metal. An English method inserts annular cores into the gates, the cores consisting of a mass which, having been ignited by the molten steel, liberates enough heat to greatly slow cooling. Preliminary test results show that the weight of runners and risers can be reduced to less than 1/3 without increasing the number of scrap castings, the gates being kept smaller.

Casting in 5,000 B.C.

"Pre-Christian Molding and Pouring Practice," E. Piwowarsky, Aachen. This interesting paper traced these practices from about 5000-5000 B.C., mentioning early work in China, Italy, Greece, Asia Minor, Egypt, and England.

Chapter Starts Cooperative Educational Program in Battle Creek Schools

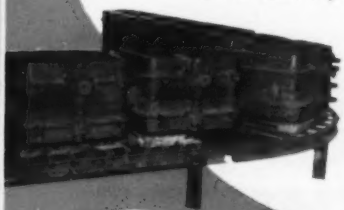
Place of the foundry in our country's complex industrial set-up and appreciation of production and use of castings rather than development of skills is the goal of a joint educational project initiated in secondary vocational schools recently by the Central Michigan Chapter, Battle Creek schools, and Michigan State College. Those who met at Albion Malleable Iron Co., Albion, Mich., to plan the program are, left to right; Prof. C. C. Sigerfoos, Michigan State College; David W. Boyd, Engineering Castings, Inc., Marshall, Mich., Central Michigan educational chairman; Frank B. Rote, Albion Malleable; Robert S. Hale, industrial training director of Battle Creek public schools; Thomas T. Lloyd, Albion Malleable, Central Michigan chapter chairman; H. A. Colburn, Battle Creek public schools; Patrick Settanni, Albion Malleable; A. W. Anderson and G. Avery Aten, Battle Creek public schools; and Ashley B. Sinnett, Michigan State.

How READING GRAY IRON discovered BS&B FOUNDRY FLASKS cut casting costs

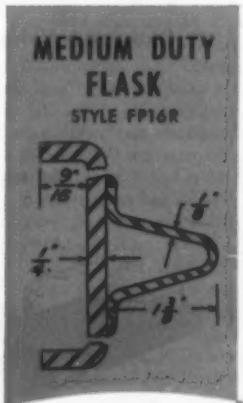
Continuous production of gray iron castings calls for foundry flasks that can "take it" without being so heavy that they slow up production. Reading Gray Iron Castings, Inc. found BS&B medium duty Foundry Flasks their answer—the lightest weight flasks at the lowest ultimate cost. After comparing maintenance, repair and replacement (as well as the preference of the molders) with other flasks, Reading has standardized on BS&B throughout in its modern, high grade jobbing foundry at Reading, Pennsylvania.

BS&B fabricated steel Foundry Flasks feature a construction that is pound-for-pound stronger. The flasks are fully welded throughout and fabricated for maximum strength and service life. The bearings are of sufficient width to help maintain rigidity and formed cold from full-gauge steel plate to prevent warpage and deformation under hard and constant use. As a result BS&B flasks have the ultimate lowest cost to the foundry—and require fewer "standby" flasks to replace flasks being repaired.

BS&B flasks are made in round, square and rectangular shapes for light, medium or heavy duty. Pinlugs, available in all styles, are standard equipment and can be had in any arrangement or combination you desire. Special flasks can be made to your specifications.



Write today for your free copy of the BS&B Foundry Flask Catalog—a most useful foundryman's handbook with complete diagrams, specifications and tables.



Cross section of BS&B medium duty flask, showing wall thickness, sandstrip width, and depth and thickness of specially formed channel rib. Minimum depth of sections is 3".

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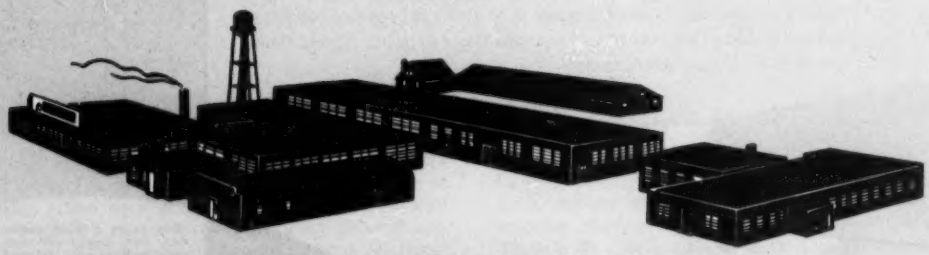

UNIVERSAL ENGINEERING COMPANY

FRANKENMUTH 12, MICHIGAN

THIS MOLD WASH WORKS WITH ALL COMMON CASTING ALLOYS

R. E. Morey
and
C. G. Ackerlind
Naval Research Laboratory
Washington, D. C.

Practical trials show that a bentonite-dextrin-silica flour mold wash developed by the Naval Research Laboratory gives excellent performance with all common ferrous and non-ferrous casting alloys, including steel, brass, bronze, aluminum, magnesium, cast iron.

IN RECENT YEARS molding sands have been improved to such a degree that most molds can now be made without the aid of a mold wash. However, in cases where the sand may be lacking in quality, or where conditions are so severe that the sand will not withstand the attack of the metal, the use of a mold wash is an expedient which will permit a satisfactory casting to be made.

A mold wash should consist of inexpensive, readily available raw materials which do not deteriorate in storage and which mix easily. The prepared mixture should be of a smooth, creamy consistency easily applied to the mold or core by brushing, spraying, dipping, or swabbing. It should not settle, ferment, or otherwise deteriorate on standing. The consistency should be thin enough to penetrate slightly into the sand to improve adherence but thick enough so that a substantial layer can be applied in a single coating.

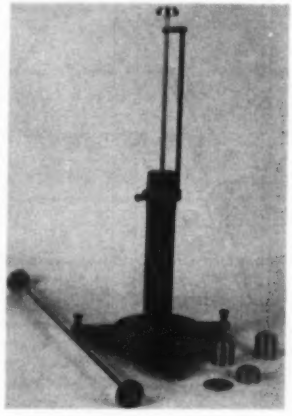

Fig. 1—Gardner mobilometer for measuring viscosity of mold washes determines property impossible to measure with hydrometer commonly used in foundries.

The coating should dry to a smooth, hard surface which will resist normal handling and abrasion. When the metal is cast, the wash should resist erosion and spalling as well as fusion and chemical attack by the molten metal. It should produce a smooth, clean casting surface which will separate readily from the sand.

Fourteen or fifteen years ago, washes used in most commercial foundries generally consisted of a little more than silica flour and water, with a small amount of low-grade molasses or sulphite liquor occasionally added to serve as a binder. Because the silica particles settled rapidly, it was necessary to stir the mixture vigorously each time this wash was used. Brush or swab application caused the removal of surface grains of the sand and produced very rough surfaces. When the layer of wash dried, it frequently cracked and peeled from the mold surface. The dried wash was so soft that it rubbed off readily.

In 1937 the Naval Research Laboratory initiated a research program to improve mold washes. The wash finally selected was given extensive practical trials and found to be satisfactory for all common ferrous and non-ferrous casting alloys, including steel, brass, bronze, aluminum, magnesium, and cast iron.

Developing the Wash

When an insoluble solid, composed of very small particles, is mixed with a liquid, the resulting suspension, if it is stable and the particles do not settle, is called a sol. In some cases the sol will, on standing, turn to a gel, or jelly-like solid. Some gels will revert temporarily to sols on shaking or stirring, and such reversible suspensions are termed thixotropic. Water suspensions of bentonite in the proper concentration are thixotropic. Bentonite is an essential agent of mold washes in that it acts to prevent normal sedimentation of other particles, even though relatively coarse.

In order to find the useful limits of bentonite concentration, a series of simple mold-wash mixtures were made. The water content was held constant at 37.5 per cent, and the bentonite was increased in small increments at the expense of the silica flour. Mixes ranging from 0.31 to 0.62 per cent bentonite were too thin to prevent settling of the silica flour; the sediment tended to cake and proved very difficult to resuspend by stirring. Mixtures with 0.94 and 1.09 per cent bentonite had a smoother, thicker consistency and held a large part of the silica flour in suspension but did not form definite gels. The precipitate did not pack firmly and was easily resuspended by mild stirring.

Mixtures with 1.25, 1.38, and 1.50 per cent bentonite held practically all the silica flour in suspension without separation of water. The gels formed in these mixtures reverted easily to sols, thin enough to apply by the usual methods. The washes with 1.62, 1.75, and 1.88 per cent bentonite formed firm gels of too thick a consistency, even during stirring, to be useful. Beakers containing these gels would not spill when inverted carefully. From these tests it appeared that bentonite should be held between 1.25 to 1.50 per cent of the total weight or 2.0 to 2.4 per cent of the dry weight of a mold wash.

Gum arabic and gum tragacanth were also tried as

NOTE: The opinions expressed in this paper are those of the authors and are not to be construed as representing the official views of the Navy Department.

suspending agents. They were not as satisfactory as bentonite, being unable to hold the silica in suspension at any reasonable concentration. Moreover, being organic in nature, they produced gas during casting, and their use was discontinued.

The dried silica flour-bentonite mold wash was found to have insufficient hardness for optimum performance. This defect was remedied by the addition of a binder which hardens on drying or baking. The use of core oils and emulsified core oils, as well as foundry-grade molasses and lignin binders, is fairly common for this purpose. Core oils and emulsified oils were eliminated after trial because of the high temperature needed to harden the oils and the difficulty of mixing the oil into water-base mixtures. Lignin binders produced considerable gas and smoke and were slightly hygroscopic. Dextrin produced sufficient strength to resist reasonable abrasion in amounts of 1.5 per cent of the total weight of wash.

Although the use of dextrin solved the problem of strength, it introduced another problem in that the wash fermented, particularly in warm surroundings. This produced a strong, objectionable odor, besides causing deterioration. To prevent or retard fermentation, small amounts of sodium benzoate were introduced into the mixture. Amounts as low as 0.1 per cent of the total weight of mold wash were effective for periods of at least 7 days, even in warm weather. Most batches would normally be consumed in less time.

Control of Wash Consistency

The density of a mold wash depends simply on the combined density of the suspending liquid and the density and amount of the materials suspended in it. Viscosity, on the other hand, depends on both the amount and nature of solids suspended in the liquid. Because of this, lightweight washes may be very viscous, and heavy washes may have relatively low viscosities. Therefore hydrometer methods are not suitable for measuring viscosity in washes which contain bentonite, even though the Baume hydrometer has been used in the foundry for this purpose for many years. Various other methods (such as the "slump" test and orifice-type viscosimeter tests) were tried to determine wash viscosity, but most of these were unsatisfactory.

The apparatus finally selected was the Gardner mobilometer*, shown in Fig. 1. It consists of a shaft supported by a guide and fitted with discs at both ends. The lower disc extends into the vertical cylinder and is slightly smaller than the inside diameter of the cylinder. After the sample to be tested is poured into the cylinder, the shaft assembly is raised and then allowed to fall freely. Since the liquid must flow through the narrow annulus between disc and cylinder, the rate of fall measures the kinematic viscosity of the sample.

Rate of fall is determined by timing the interval between the times two marks on the shaft pass the top of the guide. Since this process requires a definite volume of liquid to pass the edge of the disc, the rate of flow may be computed directly. The lowest weight which could be used was 26.5, the weight of a light aluminum plunger assembly without any additional weights. For this reason, no experimental points were obtained below this weight.

The top disc on the shaft serves as a platform for additional weights. By repeating the test with different loads, several values of flow were obtained and plotted as a function of the weight (Fig. 2, 3, 5, 6). It was expected that this relationship would plot as a smooth curve, which for true liquids would pass through the origin of the graph and the tangent slope of which would be a measure of kinematic viscosity.

For thixotropic materials, the line should intersect the weight axis at some distance from the origin, representing a measure of the gel strength, or force necessary to cause the gel to revert to a sol, while the slope of the line would be a measure of viscosity as before.

To find the effect of silica flour on the consistency

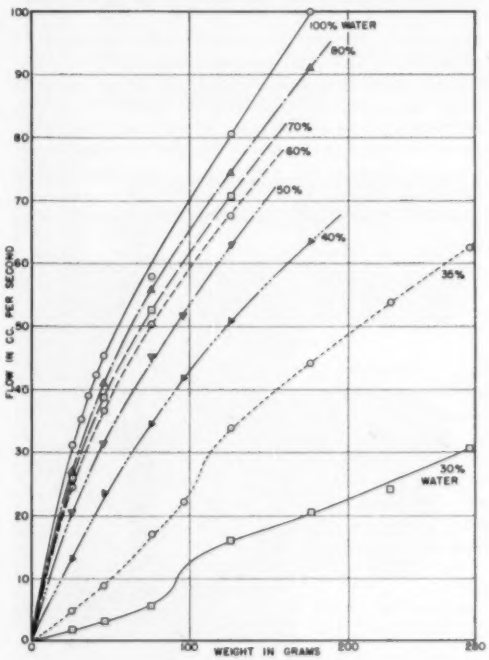

Fig. 2—Mobilometer curves for silica flour-water slurries, showing curve for water at 27 C for comparison.

of silica flour-water mixtures, a series of samples were made containing water contents from 30 to 100 per cent by weight, the balance being silica flour. These curves are shown in Fig. 2. Since they pass through the origin, thixotropy is absent, as would be expected. The specific viscosity, however, varies considerably, as shown by the difference in the slope of the various curves. The curve for water at 27 C is shown for comparison.

The viscosity gradually increases as the water is replaced by silica flour up to 50 per cent. Further increases of silica flour cause a much more rapid increase in viscosity; at 65 per cent silica flour a discontinuity in the curve was noted. A possible reason for the discontinuity is a change from streamline to turbulent

* Gardner, Henry A., *Physical and Chemical Examination of Paints, Varnishes, Lacquers, and Colors*, Fifth Ed., Institute of Paint and Varnish Research, 1930.

flow around the edge of the disc. Similar behavior has been observed for the flow of liquid in smooth pipes.

To investigate the effect of bentonite on bentonite-water suspensions, a series of mixtures were made with 5 to 10 per cent bentonite covering the range from very weak to very strong gels. These mixtures produced the curves shown in Fig. 3. Here again it is seen that the theoretical straight line relationship is not developed. The major difference between the silica flour and bentonite suspensions is that the silica-flour curves pass through the origin, while the bentonite curves intersect the weight axis at a point proportional to the gel strength of the specific mixture.

Some liberty was taken in showing the discontinuity in the 6 per cent curve, but the one point at 26.5 gm indicates it is present, as in the case of the 7, 8, 9, and 10

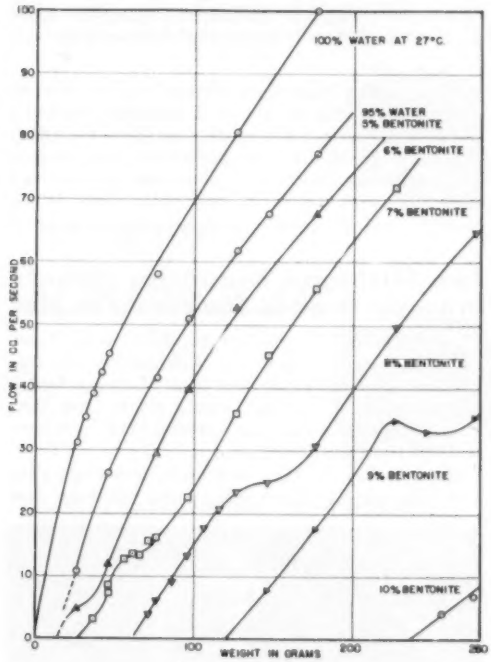

Fig. 3—Mobilometer curves for bentonite-water slurries, with comparative curve for water at 27 C.

per cent curves. For the 10 per cent mixture, the transition from streamline to turbulent flow occurs between 480 and 560 gm. The 6 per cent mixture, with an intercept of 15 gm, would barely support a glass rod vertically in a beaker, while the 10 per cent mixture with an intercept of 236 gm formed a gel so strong that the beaker could be inverted and shaken without flow.

Effect of Refractory Particle Size

Silica flour is usually ground from very pure quartz grains or pebbles, frequently having a size of ¼ in. to 20 mesh, produced as tailings from sand-grading plants. Various grinds designated as 90, 120, 140, 160, 200, and 325 mesh are commercially available. In most of the grades, the mesh number represents the sieve which will pass 95 per cent of the silica flour. In the case of the 325-mesh flour, 98 per cent must pass through the sieve.

All of these grades have been tried in mold-wash mixtures, and most perform satisfactorily. The 90 mesh, however, is excessively coarse. The 120 mesh, while coarse, stays in suspension very well and can be used on large work not requiring a smooth finish. The 140, 160, 200, and 325 grades have increasingly smooth textures, and all make good washes. The choice between these 4 grades depends on the average size of castings to be made and the finish required. Since the cost goes up quite rapidly from the 200 to the 325 mesh, the 200-mesh flour represents, for foundries producing small to medium-size castings, the best compromise between finish and cost.

Size-distribution curves of representative grades are illustrated in Fig. 4, which shows that the distribution of sizes is practically the same in any of the grades but that the median size decreases with increasing mesh number from 38 microns for the 120 mesh to 16 microns for the 325 mesh.

Samples of the improved mold wash made using the

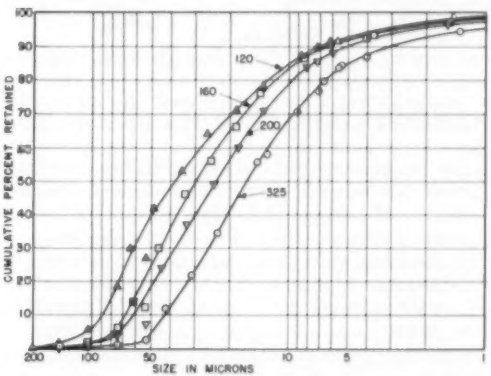

Fig. 4—Size distribution curves for various grades of silica flour. Although distribution of sizes is about the same for grades shown, median size varies significantly.

120, 140, 160, and 325 grades were tested to see if any change in consistency could be detected with change in size. The curves in Fig. 5 indicate that grain size has a very slight effect on viscosity. All 4 curves indicate a slight amount of thixotropy. The 140 grade is indicated to be the most fluid and the 325 grade the most viscous. The spread, however, is not much greater than the error that is ordinarily to be expected in production formulation.

Method of Preparation

Both bentonite and dextrin are difficult to mix with water because they form very tough lumps which resist the penetration of water. Considerable time and agitation are required to accomplish uniform suspension of the bentonite and solution of the dextrin. It was found, however, that both of these problems may be avoided by thorough dry mixing of all the

bentonite and dextrin with the silica flour before adding the water. The dry materials may then be wetted very easily. After wetting, the mold wash should be allowed to stand for about 30 minutes to permit the dextrin to dissolve and the bentonite to absorb water and expand to its maximum volume. After a final stirring, the wash is ready for use.

During mixing, care should be taken to ventilate the room properly to avoid inhalation of very fine silica particles. This should also be considered in selecting the method of application. Spraying makes very uniform and smooth coatings of mold wash, but unless adequate ventilation is available to remove the fine droplets containing silica from the air, this method should not be used. There is very little danger from brushing, swabbing, and dipping.

Mold Wash Formulas

On the basis of its performance, the following mold wash (proportions are by weight) was selected for regular use in the NRL experimental foundry:

Bentonite	1.5 per cent
Dextrin	1.5 per cent
Silica flour	59.4 per cent
Sodium benzoate	0.1 per cent
Water	37.5 per cent

As seen in Fig. 6, the intercept at 10 gm indicates slight thixotropy, and the slope shows 0.17 viscosity.

Although this wash has been used very successfully for cast iron, somewhat smoother surfaces are obtained by using graphite in place of silica flour. About the same proportions of dry materials may be used, but much more water is needed. The following mixture was selected as standard for the NRL:

Graphite	31.1 per cent
Bentonite	0.8 per cent
Dextrin	1.3 per cent
Sodium benzoate	0.1 per cent
Water	66.7 per cent

As in the case of the silica flour mold wash, the dry ingredients should be mixed prior to adding the water. Occasional stirring is necessary until the mixture has a smooth consistency free from lumps. Both

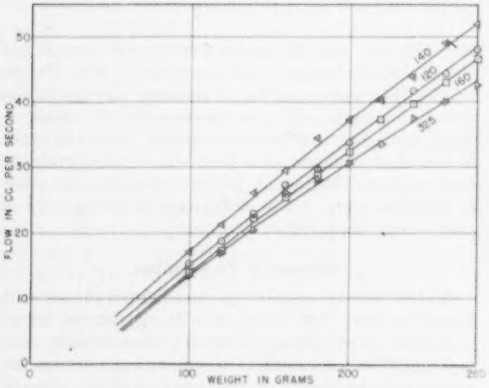

Fig. 5—Note that grain size of silica flour has little influence on viscosity of water suspensions shown above.

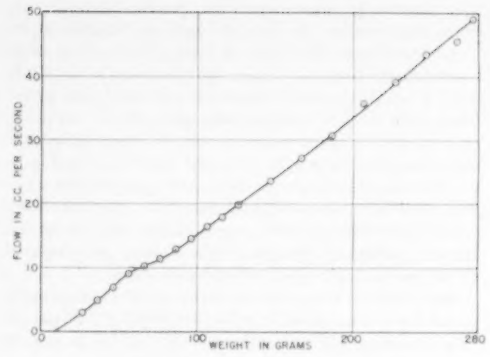

Fig. 6—Curve for bentonite-dextrin-silica flour mold wash shows slight thixotropy and a viscosity of 0.17.

of these washes have been adjusted so the binders and suspending agents are at a workable minimum, and refractory content is at the maximum consistent with easy workability. The ingredients are inexpensive, readily available, easily mixed and applied, and compatible with the metals cast against them. When properly used, they produce excellent casting finishes.

Two Michigan Foundries Donate Urgently Needed Equipment to MSC

Current activity of the Foundry Educational Foundation Advisory Committee to Michigan State College has been to secure equipment from Michigan foundries for use in the college. Initial results have been quite promising in that badly needed items have been received from two foundries.

Elmer LeBay, an MSC student, is shown operating a molding machine donated by Albion Malleable Iron

Co., Albion. Lakey Foundry & Machine Co., Muskegon, provided a dilatometer which Harry W. Dietert Co., Detroit, has offered to modernize and recondition. In addition, Albion furnished a number of flasks, pneumatic rammers, a 200-lb. pouring ladle, and a belt conveyor. Lakey Foundry & Machine Co. also supplied numerous aluminum and steel flasks to the school.

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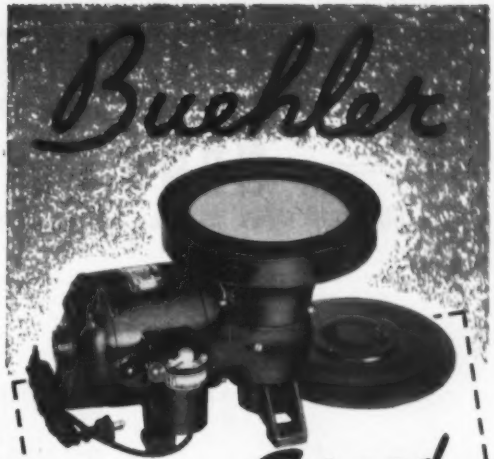

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VOLCLAY BENTONITE

NEWS LETTER No. 25

REPORTING NEWS AND DEVELOPMENTS IN THE FOUNDRY USE OF BENTONITE

A "Used-to-Be" Secret in the Cleaning Room

Years ago, companies particularly prided themselves on finish and guarded their secrets in the foundry.

Since only naturally bonded sands were used in the early time foundries, burn-in was quite frequent in the deeper pockets, corners or fillets, which may have been due to a low fusion sand, or soft ramming combined with a high moisture content.

The molding machine age had not, as yet, created a harder rammed mold with sharper detailed finish.

On un-machined surfaces such as lawn mower parts, stove parts, sewing machine parts, fittings, valves, and others too numerous to mention, detail is important as well as good surface finish.

Even by using the finest grain sand, not always was the foundry successful in obtaining a smooth casting and had to rely upon the cleaning room for help.

The secret of the cleaning room in obtaining finish was always guarded but through the ages, the secret was gradually lost.

Most cleaning rooms found it quite advantageous to use small pieces of hard wood blocks in the tumbling barrels to help remove the burned-on or burned-in sand from the casting.

To this was added old shoes and old leather belts cut up in small sections. This leather did wonders in buffing the casting during tumbling.

In order to obtain the "shine" to the casting, small amounts of anthracite coal or lump graphite were added to the tumbling mills.

After the castings were removed from the tumble mill, the smaller parts were added to a gyratory screen that would be filled with coarse sawdust chips and fines which were saturated with oil.

By vibrating the screen and allowing the sawdust chips to pass through and then reshoveling the chips into the gyratory screen once again, the castings could be delivered to the customer in excellent finish and appearance. This was copied from the jewelry industry. It also prevented rusting upon long storage.

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FOUNDRY Personalities

William J. Grede, president of Grede Foundries, Inc., Milwaukee, became the first foundryman president of the National Association of Manufacturers at NAM's 56th Annual Congress in December. Mr. Grede, who began his foundry career as assistant to the president of Wagner Castings Co., Decatur, Ill., acquired Liberty Foundry, Wauwatosa, Wis., in 1920 and

W. J. Grede

has since developed Grede Foundries into a six-plant group producing 33,000 tons of ferrous castings a year and employing 1,100 men. Mr. Grede holds executive offices and directorships in several Midwest firms; is a trustee of Carroll College; director and past president of the Wisconsin Manufacturers Association; past president of the Employers Association of Milwaukee; and past director and past treasurer of the Gray Iron Founders Society. For the last two years a vice-president of NAM, Mr. Grede is a former member of the A.F.S. Foundry Cost Committee and was active in formation of the A.F.S. Wisconsin Chapter, developed from the former Milwaukee Foundrymen's Association.

Anton F. Anderle, with Motor Patterns Co., Cleveland, since 1921, has retired. His position as general manager will be filled by **Frank J. Oklessen.** Other personnel changes include **Edward W. Pierle,** plant manager; **Michael J. Dolan,** shop superintendent; **William J. Hinchliffe,** foreman of the wood department; and **Joseph C. Helus,** foreman of the metal department.

Charles E. Nelson, Jr., was recently elected a director of Waukesha Motor Co., Waukesha, Wis. He is also vice-president in charge of production. Joining the organization in 1929 as a member of the finance department, he has served as secretary and treasurer of a company subsidiary, factory production manager, director of purchases and production planning, and assistant to the president. Mr. Nelson is a graduate of St. John's Military Academy and the University of Wisconsin.

Don S. Smith, general production manager of Wellman Bronze & Aluminum Co., Cleveland, for the past year, has been appointed vice-president in charge of production. Mr. Smith was formerly affiliated

Don S. Smith

with Aluminum Co. of America, and has been with Wellman since 1943.

Luis E. Eckelmann has been elected vice-president of Pyrene Mfg. Co., Newark, N. J. He will be in general charge of development work as well as metal finishing. Mr. Eckelmann joined the company in 1916 to do part-time research while he was still a student, and after graduation became a full-time member of the staff.

Harry Oldham was recently added to the engineering staff of Sutter Products Co., Dearborn, Mich. His 48 years' experience in ferrous and non-ferrous foundries will be applied to developing and designing new foundry equipment, particularly for

Harry Oldham

the shell molding process. Mr. Oldham was employed in various foundry capacities for Ford Motor Co. for 23 years. He has also been associated with Mack Trucks, Inc., Hunt-Spiller Mfg. Corp., and the National Steel Foundry in Scotland.

O. C. Haines was recently appointed purchasing agent for Robinson Clay Prod-

At a recent meeting, the Pontiac Motor Division, GMC, Supervisors' Club elected Cupola General Foreman Harry Arterburn (right) president, and Maintenance General Foreman Clifford McLean (left) vice-president. Congratulating both is Club Member George Collingwood, superintendent.

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uct Co., Akron, Ohio, succeeding the late Maurice J. Tucker. Mr. Haines, who has been associated with Robinson for the past 17 years, will supervise purchasing operations for all the company's plants and branches. Beginning as a member of the office staff, he has also served in accounting, production, and purchasing. Haines is a graduate of the University of Akron, and saw 30 months' duty with the Seabees during World War II.

O. C. Haines

Phil Block is the new special sales representative for Frederic B. Stevens, Inc., Detroit, in the foundry sales department. He has been assigned the Detroit area. Block has over 17 years' practical foundry

Phil Block

experience, much of it gained with Michigan Steel Casting Co. which he joined soon after his studies at Detroit Institute of Technology.

Norman J. Dunbeck, formerly vice-president, Eastern Clay Products, Inc., Jackson, Ohio, was elected a vice-president of International Minerals and Chemical Corp., when that organization acquired Eastern Clay Products recently. Mr. Dunbeck will be in charge of a newly formed Industrial Minerals Division and will continue to supervise International's Eastern Clay Products Dept. Mr. Dunbeck is a past National Director of American Foundrymen's Society, past chairman of the A.F.S. Central Ohio Chapter and has served on A.F.S. technical committees.

(Continued on Page 77)

Illustration shows cope and drag set on fender pattern for STAR PATTERN & MFG. CO., Benton Harbor, Mich.

for Higher Casting Production...

look to **ACCURATE** cope and drag sets

Because they have been a profit maker for several hundred of the leading foundries all over America...

For example, when you use Accurate cope and drag sets you get clean smooth partings. Patterns as cast are straightened and have correct alignment marks. This helps to decrease your finishing costs.

Maintenance costs are much lower because you get longer life..

Wherever used, Accurate cope and drag sets have been the means of producing greater volume of castings at lower costs.

Why not apply this idea to your foundry? It has been profitable to others and will be to you, too.

Write for catalog No. 115. It tells the whole story.

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By Air Freight, Parcel Post, Special Delivery or Railway Express. Pick-up & delivery by jobber representatives in the following areas:

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WHEREVER THE HOT STUFF HITS

USE NATIONAL CARBON

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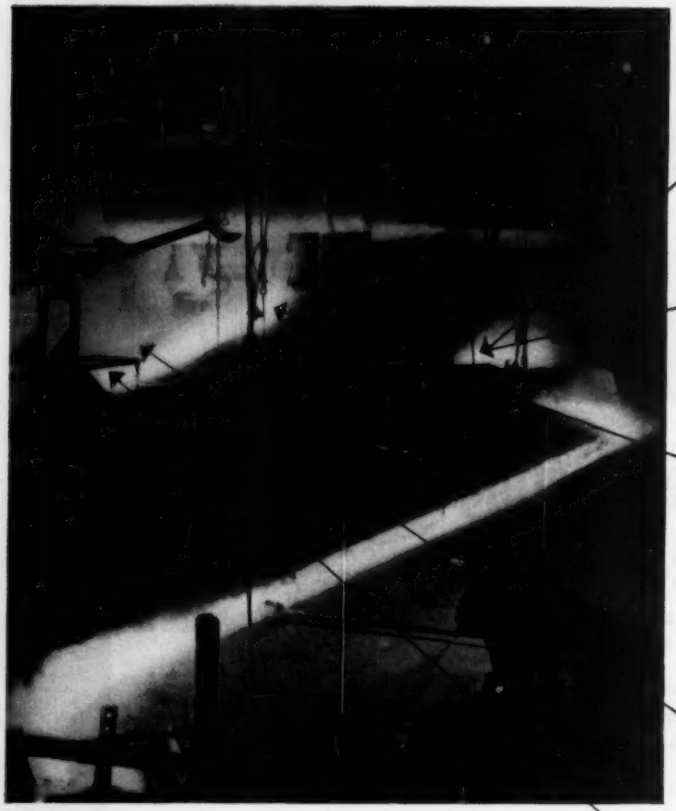
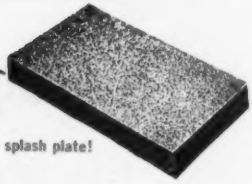


For the cinder notch liner!

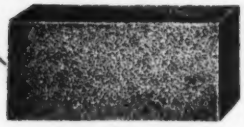
For the cinder notch plug!



For the splash plate!

For the runout troughs!

For the skimmer plate!



● "National" carbon is now firmly established for blast furnace linings. It is being used outside the furnace as well—wherever there is contact with molten material—for the splash plate, runout troughs—clear down to the ladle—skimmer plate, cinder notch liner and cinder notch plug.

The reasons?

"National" carbon has no melting point. It is highly resistant to slag attack and thermal shock . . . not wet by molten metal . . . has a low thermal expansion . . . and maintains its mechanical strength at elevated temperatures.

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PERSONALITIES

(Continued from Page 74)

James F. Pace has recently been appointed director of sales, Core Oil Div., United Oil Mfg. Co. Mr. Pace joined United Oil in 1936, subsequently serving as special representative, oil technician, and assistant to the president. The company's main offices are in Erie, Pa.

Charles J. Paumier will serve Electric Furnace Co., Salem, Ohio, as their Pacific coast representative, covering California, Washington, Oregon, and the bordering states. Mr. Paumier was formerly connected with Revere Copper & Brass Co.

F. Okumura, president Nippon Steel Foundry Co., Osaka, Japan, spent November and December in the United States visiting foundries producing rolls, machinery castings, turbine castings, railroad, and ship parts. Future plans for his company call for expansion and modernization along the pattern established by American foundries to get higher production. While visiting the National Office, Mr. Okumura joined A.F.S. He is director and general manager of the Osaka Branch Office of the Japan Cast Steel Society.

D. Frank O'Connor, president, O'Connor's Foundry, Inc., Hackettstown, N. J., has taken a position as foundry consultant with the Economic Cooperation Administration and will have headquarters in Rome, Italy. He was elected chairman of the Metropolitan Chapter of A.F.S. for 1951-52 and is a past chairman of the Sand Division.

C. Walter Ostrand, general manager, Caldwell Plant, Link-Belt Co., Chicago, was elected president of Conveyor Equipment Manufacturers Association at its annual meeting, Oct. 30. He succeeds **L. B. McKnight,** executive vice-president, Chain Belt Co., Milwaukee. **R. C. Sollengerger** was re-elected executive vice-president. Other officers are: **Harry C. Davis,** general manager and chairman of the board, Kanawha Mfg. Co., Charleston, W. Va., vice-president; **R. F. Tomlinson,** general sales manager, A. B. Farquhar Co., York, Pa., treasurer; and **Lee Sekulski,** sales manager, Mathews Conveyor Co., Ellwood City, Pa., secretary for a second term. Elected to the executive committee were **J. A. Jeffrey,** vice-president, Jeffrey Mfg. Co., Columbus, Ohio; **J. E. McBride,** vice-president, Palmer-Bee Co., Detroit; and Mr. McKnight.

S. T. Jazwinski has taken the position of chief metallurgist for Central Iron and Steel Co., Harrisburg, Pa., and subsidiaries. Mr. Jazwinski was formerly senior staff engineer, metallurgical department, Ford Motor Co., Detroit.

Norman C. MacPhee, metallurgist with the Mines Branch, Canadian Department of Mines and Technical Surveys, has been selected by the Civil Service Commission as chief of the division of physical metallurgy. He succeeds **Dr. John Convey,** who recently became branch director. Mr. MacPhee had a long and varied career in the foundry and metallurgical industries of both Canada and the United States before joining the Bureau of Mines in 1941. He is the author of numerous publications on various phases of the foundry industry, and is active in a number of mining, metal, and foundry associations. He is a director of the Eastern Canada Chapter.

Norman E. Craig, New York resident manager of Hickman, Williams & Co., has been elected to the company's board of directors.

Walter T. Sullivan, general foundry superintendent of General Steel Wares, Ltd., London, Ontario, Canada, has been awarded his 50-year service button by A.F.S. Beginning his apprenticeship at the age of 15, Mr. Sullivan came to the United States in 1904 only to return to Canada in 1907 where he has been ever since. His experience includes all forms of foundry techniques.

OBITUARIES

William M. Booth, consultant and chemical engineer of Chittenango, New York, died October 22. He had been a member of A.F.S. since 1929 and was a charter member of the Institute of Chemical Engineers. A Harvard graduate and former teacher, Mr. Booth conducted several courses in metallurgy at Crouse-Hinds Co., Syracuse, N. Y., in addition to his consultant services there.

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PROPER CORE SAND RECOMMENDATIONS
Sand has gone scientific! Today modern foundries can rely on their sand suppliers for the proper recommendations to meet their specific needs. Cannon Brand Core Sand is being tested and improved continually by up-to-date laboratory methods to guarantee highest foundry standards. Guesswork is eliminated at our plant—not yours.
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THE NUGENT SAND COMPANY, INC. Since 1912 MUSKEGON, MICHIGAN

Reading from left at the speakers' table during Cincinnati District Chapter's November 12 meeting were: Daniel O'Donnell and Treasurer H. R. Rost of Semet Solvay Div., Allied Chemical & Dye Corp.; Howard F. Ramsey, Foundry Products Div., Archer-Daniels-Midland Co.; Chairman A. W. Schneble, Jr., Advance Foundry Co.; Speaker Werner B. Bishop, Foundry Products Div., Archer-Daniels-Midland Co., Cleveland; and Vice-Chairman Burt A. Genthe, S. Obermayer Co. Photo courtesy M. L. Steinbuch, The Lunkenheimer Co.

CHAPTER ACTIVITIES NEWS

Eastern Canada

M. McQuiggan
C. O. Clark & Bro.
Chapter Reporter

Two-day foundry conference was held at Three Rivers, Que., by the chapter on November 2 and 3, with W. C. Perrot, Canada Iron Foundries, Ltd., as chairman.

First day's program began with plant and school visits. A large number of foundrymen were taken through the Three Rivers Technical School, where arts and crafts of all kinds are taught, including foundry, patternmaking and shop practice, with modern equipment and expert teachers.

Featured on a visit to Canada Iron Foundries, Ltd., were production of cast iron pipe by the DeLavaud process, casting of brake shoes, conveyorized mold and casting handling equipment, and continuous melting and pouring practices.

In the evening a get-together at the Chateau de Blois Hotel featured songs by the Canada Iron Foundries Glee Club under the direction of James Clark. Mayor J. A. Mongrain of Three Rivers welcomed foundrymen at the dinner. Guests introduced included A.F.S. National Director J. J. McFadyen, Galt Malleable Iron Co., Galt, Ont.; A.F.S. Technical Director S. C. Massari; Ontario Chapter Vice-Chairman Andrew Reyburn; Marc Boyer, Deputy Minister of Mines and Technical Surveys; Dr. John Convey, Chief, Bureau of Mines; and Marcel Ouellet, Three Rivers Industrial Commissioner.

Following dinner, the technical session took the form of a *"Casting Morgue,"* with an "inquest" held on a number of defective castings supplied by several foundries. This gave rise to an interesting discussion of

Mayor J. A. Mongrain of Three Rivers, Que., welcomed foundrymen to Eastern Canada Chapter's two-day Foundry Conference November 2 and 3. Left to right, seated, are: Chapter Chairman W. Turney Shute, Canadian Car & Foundry Co.; A.F.S. National Director J. J. McFadyen, Galt Malleable Iron Co.; Conference Chairman W. C. Perrott, Canada Iron Foundries, Ltd.; and A.F.S. Technical Director S. C. Massari. Conference program included a dinner and technical session and visits to schools and foundries.

causes and corrective measures, led by Henry Louette of Warden King, Ltd., Montreal.

November 3 program opened with a tour of Canadian International Paper Co., Ltd.'s newsprint mill, said to be the world's largest. Here, foundrymen saw some of their own castings at work.

The Conference wound up with a pleasant luncheon sponsored by Canada Iron Foundries, Ltd. This first Three Rivers Conference was attended by foundrymen from as far east as Sydney, Nova Scotia, and St. Johns, New Brunswick, as well as from Quebec, Ontario and the United States.

Texas

F. M. Wittlinger
Texas Electric Steel Casting Co.
Chapter Reporter

NOVEMBER 16 MEETING, held at the Dallas Athletic Club, Dallas, was attended by 61 members and guests and featured a showing of the A.F.S. Aluminum & Magnesium Division's research film in sound and color, *"Fluid Flow in Transparent Molds—II."* This was followed by a panel discussion of the points brought out in the film. Charles Sibbitt, Refinery Castings Co., Dallas, headed the discussion, in which the entire group participated.

Discussion proved of such interest that after 45 minutes Mr. Charles found it necessary to close the valves and pull the fires in order to disband in time for the next month's meeting.

James Hewitt was given a wrist watch by the chapter in recognition of his outstanding work as general chairman of this year's Texas Regional Foundry Conference, and has consented to be chairman of the 1952 Conference, to be held at either Fort Worth or Dallas.

Washington

Harold R. Wolfer
Puget Sound Naval Shipyard
Chapter Reporter

NOVEMBER 15 MEETING, held at the Frye Hotel, Seattle, featured a talk by Ralph L. Lee, Grede Foundries, Inc., Milwaukee, on *"Do You Know Your Costs?"* Mr. Lee stressed the importance of knowing true costs and using them to control present and future operations. No cost system, he pointed out, is of value unless it is used to judge current operations.

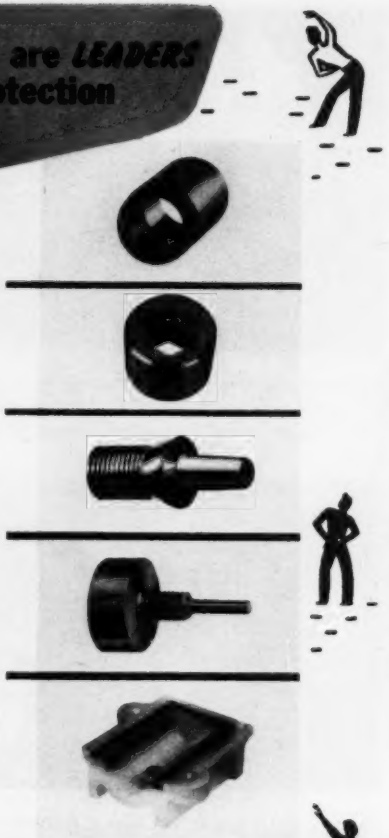
Mr. Lee advocated that all jobs be classified as to size and type and priced per piece instead of per pound. Experiences at Mr. Lee's firm have shown that 90 per cent of all jobs, if properly classified, will agree with standard estimates set up for these different categories. The remaining 10 per cent, he said, must be given fullest attention

Guests of the Oregon State College Student Chapter during their recent West Coast tour were A.F.S. National Vice-President I. R. Wagner (second from left) and A.F.S. Secretary-Treasurer Wm. W. Maloney (fifth from left).

Chapter Chairman W. T. Bland, Commercial Steel Castings Co., Marion, Ohio, welcomes lady guests to Central Ohio Chapter's Christmas Dinner Dance, held December 8 at Brookside Country Club, Columbus. Photograph courtesy Wilfred H. White, Jackson Iron and Steel Company, Jackson, Ohio.

Discussing a safety saw blade following the November meeting of the Washington Chapter are, from left: Edward Rowe, University of Washington; E. J. McAfee, Puget Sound Naval Shipyard, Bremerton, Wash.; and Chapter Chairman James Tracy, Salmon Bay Foundry Co., Seattle.

These Products are *LEADERS* in Core Box Protection by MARTIN



"SAND ARRESTER TUBE"
Save cores and step up production. Guaranteed for 100,000 blows.

"HOLINER" BUSHINGS
Stop abrasion between blow plate and core box. Protect blow holes.

"PROTEXABOX PINS"
Cannot mar the box face because they will not loosen. Protective rubber tip guaranteed to stay on.

"PULLINSERT" BLOW BUTTONS
Positively stop sand blasting under blow holes. Available in nine popular sizes.

"STRIPINSERT"
Protects parting line—easily installed in old or new boxes. Cutters for groove available at moderate cost.

"VIBROLATOR"

Rugged all-directional vibration that does not harm the faces of your sand hoppers or bins. Instantly self-starting, needs no lubrication or maintenance. Specify—the Peterson VIBROLATOR.

and NOW... **A NON-BINDING FLASK PIN**

No more production stoppages due to bending or binding of flask pins. No matter how much abuse these pins receive, they flex and absorb it without binding or breaking. They don't require excessive tolerances or skilled labor.

WRITE for descriptive literature or ask your distributor.

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by the cost team, because these are the jobs that can be changed from loss-producers to profit-makers.

Metropolitan

William T. Bourke
American Brake Shoe Co.
Publicity Chairman

SECOND MEETING of the season, held November 5 at the Essex House, Newark, N. J., had as its speaker J. E. Rehder, Bureau of Mines and Technical Survey, Mines Branch, Ottawa, Ont., Canada. Evening's technical chairman was Richard A. Flinn, American Brake Shoe Co., Mahwah, N. J.

A.F.S. National Secretary-Treasurer Wm. W. Maloney outlines plans for the 1952 A.F.S. International Foundry Congress in Atlantic City next May to members of the Chicago Chapter. Looking on at right is D. A. Farrell, United States Steel Co., December 3 meeting's speaker of the evening.

Speaking on the *"Graphitization of Cast Iron,"* Mr. Rehder said that much malleable foundry data has been ignored by gray iron foundrymen, although the same principles apply to the entire cast iron family.

The speaker advocated the use of higher temperatures to save time in first stage graphitization. A temperature of 1700 F will take a third less time than is required at 1600 F, he said. Annealing time, he continued, is dependent on section size and is usually determined by trial and error.

Decomposition of pearlite, Mr. Rehder said, can be accomplished by slow cooling from 1700 F rather than by holding below the critical temperature. In conclusion, the speaker discussed the effect of various elements on graphitization and presented preliminary data from his investigation.

N. Illinois - S. Wisconsin

J. S. Zabel
Zabel Foundry Sales, Inc.
Technical Secretary

NOVEMBER MEETING, held at Beloit Country Club, Beloit, Wis., November 13, was "International Night." A.F.S. Director Frank W. Shipley, Caterpillar Tractor Co., Peoria, Ill., made a short speech on the coming International Foundry Congress.

William Shinn, Gunite Foundries Corp., spoke on the Chapter's membership drive.

Chairman Carl Dahlquist, introduced Bradley Booth, Carpenter Brothers, Inc., Milwaukee, who spoke on "*Sands.*"

J. E. Rehder's topic at Metropolitan Chapter's November meeting was "Graphitization of Cast Iron." Photograph courtesy W. G. Ettinger, American Brake Shoe Co.

Mr. Booth urged all foundrymen to familiarize themselves with two A.F.S. publications: FOUNDRY SANDS AND CLAYS and ANALYSIS OF CASTING DEFECTS. The speaker maintained that too much or too little moisture causes a great number of casting defects and went on to stress the importance of sand testing in making quality castings.

Ontario

Charles Thompson
Galt Malleable Iron Co., Ltd.
Chapter Reporter

OCTOBER 26 MEETING, devoted to a panel discussion of "*Casting Design*," was attended by 240 members.

Discussion panel consisted of Chairman H. H. Fairfield, Wm. Kennedy & Sons, Ltd.; John Perkins, Ford Motor Co. of Canada, Ltd.; Robert Robertson, International Harvester Co. of

2-WAY PROTECTION FOR MAGNESIUM FIRES

PREVENT FIRES IN POURING AND HEAT-TREATING OF MAGNESIUM . .

. . . INSTALL AN ANSUL POSITIVE CONTROL SO_2 SYSTEM

The danger of fire is a constant threat in pouring and heat treating of magnesium. . . . you can reduce this ever present danger by installing:

1. An Ansul SO_2 System for mold flushing immediately before pouring, and
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The use of Ansul SO_2 Systems reduces the fire hazard by preventing oxidation, reaction and ignition of magnesium and its alloys during pouring and heat treating operations.

Ask for your copy of bulletin No. A 940. In addition you can also obtain the services of one of Ansul's Chemical Engineers without cost or obligation. He will gladly cooperate with you in developing systems for your foundry.

EXTINGUISH FIRES IN THE CLEANING & MACHINING OF MAGNESIUM CASTINGS

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ANSUL MET-L-X DRY POWDER FIRE EXTINGUISHERS

MODEL MX 30-A

Ansul Met-L-X Dry Powder Extinguishers are designed to allow safe application of a special extinguishing compound for burning metal fires.

Ansul Met-L-X Dry Powder is particularly effective when applied to magnesium turnings, chips and castings.

Get the facts. Write for File No. 695. You will receive complete information and other valuable data.

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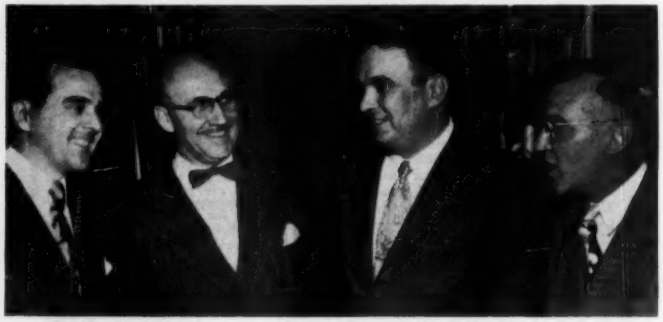
Chesapeake Chapter officers and directors photographed during a recent directors' meeting were, seated, from left: Donald A. Roemer, Balmar Corp.; Chairman A. S. Kittrell, Leach Pattern Shop; T. B. Belfield, Cochrane Foundry. Standing: L. H. Gross, American Radiator & Standard Sanitary Corp.; W. H. Holtz, American Brake Shoe Co.; L. E. Gaffney, Arlington Bronze & Aluminum Corp.; Eugene H. Ryer, James J. Lacy Co.; W. O. Becker, Atlantic Abrasive Corp.; C. A. Robeck, Gibson & Kirk Co.; J. W. Mentzer, Lancaster Foundry Supply Co.; and M. J. Kelley, Kelco Corp.



Shop talk session after Central Illinois Chapter's November meeting featured, left to right: Chapter Chairman R. E. Dickison, Brass Foundry Co.; Henry Felten, Peoria Malleable Castings Co.; Speaker George W. Anselman, Beloit Foundry Co.; and George Rockwell of Caterpillar.

Inspecting a combustion furnace in the foundry laboratory during Missouri School of Mines Student Chapter's November 20 meet were, from left: Metallurgy Dept. Chairman A. W. Schlechten; A.F.S. National Director Albert L. Hunt, American Brake Shoe Co.; Henry Meyer, General Steel Castings Co.; MSM Dean C. L. Wilson; and FEF Director George K. Dreher.

Canada, Ltd.; Andrew Reyburn, Cockshutt Plow Co., Ltd.; Alex Pirrie, Standard Sanitary & Dominion Radiator, Ltd.

George Cleary, Massey-Harris Co., Ltd.; George Winkworth, Toronto Foundry, Ltd.; and John Hughes, John T. Hepburn, Ltd.

Each member of the panel spoke briefly on his personal experiences with casting design problems and told of methods used in overcoming them. Conclusion was that cooperation between the design engineer and the foundry could eliminate the majority of design difficulties.

Detroit

R. Grant Whitehead
Claude B. Schneible Co.
Chapter Reporter

SOUND, COLOR FILM, "*The A-D-M of* Cores," was shown and discussed at the November 15 meeting by Werner B. Bishop, Foundry Products Div., Archer-Daniels-Midland Co.

The film, a very fine production, provides a good refresher course in core room practice. After the showing, Mr. Bishop answered questions on mixing sequences, effectiveness of moisture, importance of screened sand, and proportions of ingredients for various strength tests.

Chairman Vaughn C. Reid, City Pattern Foundry & Machine Co., Detroit, introduced several past chapter chairmen and guests.

Twin City

J. D. Johnson
Foundry Products Div., Archer-Daniels-Midland Co.
Chapter Reporter

NEARLY 100 MEMBERS and guests attended the November 13 meeting to hear three speakers. First, A.F.S. National Vice-President I. R. Wagner outlined activities of the Society.

Next A.F.S. National Secretary-Treasurer Wm. W. Maloney told of plans for the forthcoming A.F.S. International Foundry Congress to be held next May in Atlantic City. Hotel accommodations will be more than adequate to house the record attendance anticipated, Mr. Maloney said.

Main speaker was Fred B. Skeates, Link-Belt Co., Chicago, who discussed "*Safety Through Mechanization*" and "*Conservation of Manpower Through Conservation of the Man Hour.*"

Mr. Skeates said that the iron and steel casting industries produced 13,900,000 tons of finished castings with 230,000 less employees in 1950 than in 1949. The average employee, he said, produced 60.5 tons in 1950. Because of defense mobilization, the speaker continued, 1951 will see some 18,000,000

tons of finished castings produced with still fewer employees, because of new mechanization and safety practices.

From 1948 to 1950, the foundry industry climbed the scale of basic industry safety records from sixth from the bottom to 15th from the bottom. The four most important factors in foundry safety, Mr. Skeates concluded, are (1) good housekeeping, (2) preventive maintenance, (3) proper goggle use, and (4) proper respirator use.

Last program feature was the film *"The A-D-M of Cores,"* produced by Archer-Daniels-Midland Co.'s Foundry Products Division. This factual sound color movie ties control tests to actual foundry operation and proved extremely popular with the audience.

Eastern New York

Robert A. Rege
Eddy Valve Co.
Publicity Chairman

SECOND TECHNICAL MEETING of the year, held at the Circle Inn, Latham, October 16, had as its speaker Fred Hanson, Electro Metallurgical Div., Union Carbide & Carbon Corp., on *"Gray Iron Foundry Practice."*

Narrowing this rather general subject down to the alloying of base irons, Mr. Hanson presented pertinent data on the successful use of new ferro-alloys.

Centering his talk on substitute alloys, the speaker said that chromium used as an alloying element can produce the same effect as a combination of nickel, chromium and molybdenum in automotive cylinder alloys.

The meeting concluded with a discussion of local alloying problems.

Missouri School of Mines

Jack H. Thompson
Chapter Reporter

TWO SPEAKERS headed the November 20 meeting program. Initial speaker was Clarence Culbertson of Great Lakes Carbon Corp., who discussed *"Cupola Operation,"* in which he described fundamentals of operation and outlined cupola procedure.

Second speaker, George K. Dreher, executive director, Foundry Educational Foundation, discussed the *"Why, How and What of the Foundry Educational Foundation,"* in which he summarized the founding, growth and accomplishments of the Foundation and told how students, universities and industry benefit from its works.

Preceding the meeting, in the afternoon FEF representatives met to discuss foundry educational problems with MSM faculty members. Following the meeting, visitors were taken for a tour of the school foundry.

(Continued on Page 89)

Participants in a shell molding demonstration at Michigan State College Student Chapter's November 17 meeting were, from left: William Ochenski, City Pattern Foundry & Machine Co., Detroit; Student Chapter Chairman Wesley Hauschildt; Student Ernest Frens, Vaughn C. Reid, City Pattern Foundry & Machine Co.; and Chapter Secretary-Treasurer Herb Schlachter.

Listening to Robert Scott, Commercial Steel Casting Co., Marion, Ohio, speak on "Good Housekeeping Pays Off" at Toledo Chapter's November 14 meeting are, seated from left: Chapter Chairman John Mescher and George Zang, both of Unitcast Corp., and John G. Blake, Alloy Founders, Inc.

A few of the 240 Ontario Chapter foundrymen who heard a panel discussion of "Casting Design" at the Chapter's October 26 meeting in Toronto.

This combination increased Lining Life

4 FULL WEEKS

on our Arc Type Electric Furnaces!

HY-TEMP REFRACTO REFRACTORY BRICK PAT. NO. 2567888

HY-TEMP REFRACTO BONDING CEMENT PAT. NO. 2567888

HY-TEMP REFRACTO ELECTRIC FURNACE BOTTOM MIX PAT. NO. 2567888

CASE HISTORY #135

We produce semi-steel cam shafts of an extremely critical analysis. Formerly, we used 13½" silica linings in our electric furnaces and had to re-line them weekly; sometimes shutting them down before a week's run because the linings would go out.

Now we have linings of HTR Refractory Brick and HTR Bonding Cement that are running 4 to 5 weeks and instead of 13½" linings, we use a 9" HTR Lining. This gives us increased melting capacity . . . tremendous labor savings . . . greatly reduced down time!

In addition, we've put bottoms of HTR Refractory Brick, Bonding Cement and HTR Electric Furnace Bottom Mix in our units. These bottoms have withstood a year's running without evidence of deterioration or reduction in thickness.

Specify HTR for Best Results BY FAR!

The ability to withstand severe "burning in" . . . producing surfaces that are slag-resisting, abrasion-retarding . . . these are the essential properties of HY-TEMP REFRACTO Bricks, Bonding Cement and Bottom Mix that will greatly reduce your electric arc melting costs. Case History No. 135 is only one of many factual instances in which HY-TEMP REFRACTO MATERIALS have turned re-lining time into production time . . . reduced lining thickness and transformed it into additional melting area. Easily applied . . . easily inventoried . . . simple to maintain . . . HTR MATERIALS are your answer to efficient, economical electric arc melting production.

CHECK THIS PERFORMANCE SCORE
Based on Facts in Case History #135

	Previous Material	HTR Material
Lining Thickness	13½"	9"
Re-Lining Time in Year of Running	Average of 43-2/3 Days	Average of 12 Days
Bottom Thickness	18"	13"
Bottom Life	3 Months	On 2nd Year

Information on HTR REFRACTORY MATERIALS, specifically formulated for use in electric arc melting, is available on request. HTR Service Engineers will advise you without obligation.

HY-TEMP HTR REFRACTO MATERIALS

NATIONAL FOUNDRY SAND CO.

HY-TEMP REFRACTO MATERIALS • BRICKS • BONDING CEMENTS • ELECTRIC FURNACE LININGS AND BOTTOMS

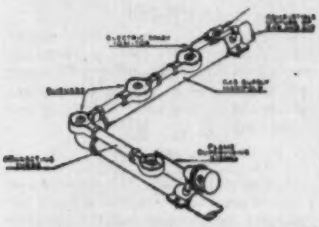
EXECUTIVE OFFICES 1770 WEST GRAND BLVD., DETROIT, MICHIGAN

NEW Foundry Products

For additional information on New Products, use postcard at bottom of this page.

Gas Burner Ignition System

1—System for igniting radiant heat burners assures operational safety. Burners are arranged in series on gas supply manifold and ignited at one end by



electric spark. Closed circuit energizes automatic gas supply at same instant, permitting gas to reach all burners by means of gas supply manifold and connecting tubes. Flame supervising device on last burner of series is located opposite spark igniter. If supervising device's contacts are not closed by flame in ignited gas burner, automatic gas supply valve closes, shutting off gas supply to all burners. *Burdett Manufacturing Co.*

Power Press Guard

2—Sweep-type guard is particularly adaptable to short-stroke, long-die power presses, and is mounted on hinged bar so that it can be swung to one side while dies are changed and press adjustments made. When ram is in up position, both guard arms are suspended in front of center of bolster plate, one arm in front of other. As ram descends, arms swing right and left and entire press working area is swept clear before downward stroke has progressed far enough to close on fingers or hands. Each arm travels at half the speed required by a single arm guard to cover the same area. Unit can be equipped with a reset counter that records each downward stroke. *Searfoss Metal Products, Inc.*

Induction Furnace

3—LECO IH-10 high frequency induction furnace features a relatively new method of burning iron and steel samples for combustion carbon analyses. Jet combustion tube jets oxygen into sample, where it is immediately consumed, insuring instantaneous starting of combustion and complete burning of sample. Over-all result is to eliminate sample preheating, to burn sample in minimum amount of oxygen, and to make full use of exothermic reaction between iron and oxygen. Features: small current consumption; available for instant use after 45 second warmup; fast analysis; cooler operation; convenient loading; and temperatures to 3000 F or more. *Laboratory Equipment Corp.*

X-Ray Film Viewer

4—Iris-diaphragmed high-intensity viewer allows study of highest range of x-ray film densities hitherto possible in industry. Opening can be steplessly dilated or contracted from a ¼-in. triangle to a 5-in. circle. Special 100,000 candlepower lamp is used, with an average life of 1,000 hours at 115 volts. Film densities of 0.5 to 4.5 can be penetrated, allowing radiographer to diagnose object of greatly varying thickness with only one exposure, and eliminating need for retakes on over-exposed films. Foot switch leaves both hands free. *General Electric Co., X-Ray Dept.*

Strapping Tape

5—No. 211 Behr-Cat strapping tape for binding of odd-shaped or contoured binding is made from reinforced glass filament. Tape is designed for use where metal strapping is subject to curtailment

(Continued on Page 97)

Reader Service (JANUARY/52)

AMERICAN FOUNDRYMAN

Please send me detailed information on New Foundry Products and Foundry Literature items circled below.

NAME_____ TITLE_____

COMPANY_____

ADDRESS_____ CITY_____

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
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AMERICAN FOUNDRYMAN
616 S. Michigan Avenue
Chicago 5, Illinois

FOUNDRY Literature

For additional information on Foundry Literature use postcard at bottom of this page.

Electric Furnace Maintenance

8—Entitled "Maintenance Guide for Electric Heat Treating Furnaces," 18-page bulletin includes a handy check sheet for simplifying maintenance schedules. *Hevi Duty Electric Co.*

Year's Research

9—Comprising 58 pages, Armour Research Foundation's yearly report outlines its research program for 1950-51. Illustrations show facilities and selected personnel. *Armour Research Foundation of Illinois Institute of Technology.*

Disc Grinding

10—Modern methods of flat surface disc grinding are shown in 32-page catalog, "Modern Methods of Gardner Grinding." Each page shows an actual job, giving specifications on equipment used and outlining benefits derived from the operation. Catalog is well illustrated with photographs and line drawings, and also contains data on abrasive discs. *Gardner Machine Co.*

Research Facilities

11—This thoroughly illustrated bulletin describes Battelle's research facilities from all angles. Additional contents include list of fields, subscribers, and volume of research. *Battelle Memorial Institute.*

Cutting Oils

12—To aid in selecting the proper straight cutting oil or base for specific operations, 4-page bulletin gives general recommendations for series of fortified and concentrated cutting fluids. *E. F. Houghton & Company.*

Quiet Vibrators

13—Four-page Catalog 108 offers data on a line of pneumatic vibrators that are air-cushioned for quiet operation. Complete line includes 29 mountings and 14 piston diameter sizes. *Cleveland Vibrator Co.*

Abrasive Points

14—Line of abrasive mounted wheels and mounted points with removable spindles are offered in 4-page Form ESA-65A. Wheel or point simply screws off the spindle without removing it from the chuck. *Simonds Abrasive Co.*

Conveyors and Ovens

15—This 16-page bulletin shows cable conveyors, freight ladders, belt conveyors, and a line of infrared ovens. All are illustrated and specified. *Triangle Equipment Co., Inc.*

Welding Data

16—"Pocket library" of welding data contains 72 pages of detailed information on low-temperature welding alloys, heating methods, melting temperatures, tensile strengths, corrosion factors, etc. Booklet is well illustrated. *Eutectic Welding Alloys Corporation.*

Electric Trucks

17—Bulletin of 12 pages gives specifications and selection factors for line of electric trucks in capacities from 1,000 to 100,000 lb. *Philadelphia Div., Yale & Towne Mfg. Co.*

Hot Blast

18—Bulletin FO-3 gives complete information on the advantages of using hot air for combustion. It tells how hot blast increases melting rate, produces better iron with less coke, lowers sulphur pick-up, reduces oxidation, gives closer control, and saves pig iron. *Whiting Corp.*

(Continued on Page 88)

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Chicago 5, Illinois

Reader Service (JANUARY/52)

AMERICAN FOUNDRYMAN

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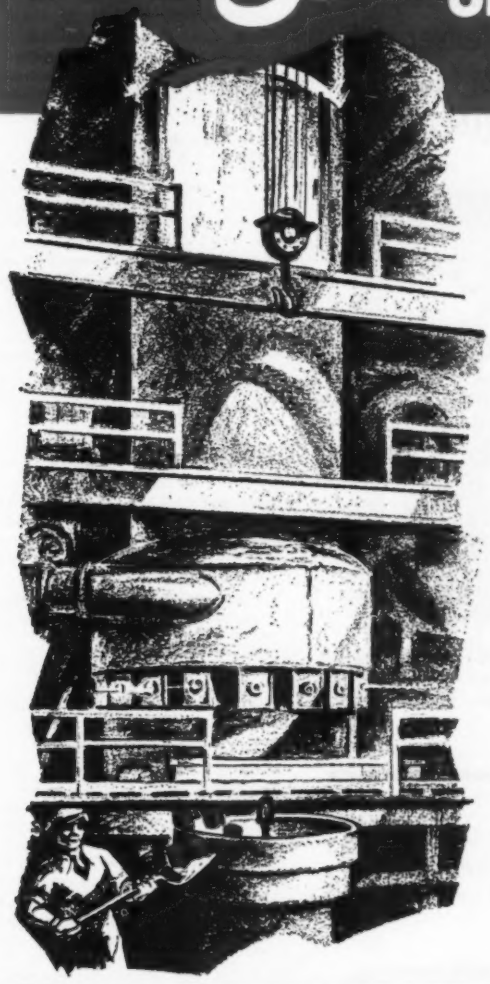
YOU'RE SURE WHEN YOU USE OHIO FERRO-ALLOYS BRIQUETS



You gain the benefit of positive analysis control when you use Ohio Ferro-Alloys Briquets for silicon, manganese and chrome addition to the cupola. Their use as regular practice allows a wide latitude in making up the charge from available pig iron and scrap.

THE FOLLOWING ARE AVAILABLE

Kind of Ohio Ferro-Alloys Briquet	Color	Contained Alloy
Silicon	black	Two Sizes { 1 lb. Silicon / 2 lb. Silicon
Silico-Manganese	yellow	½ lb. Silicon and 2 lb. Manganese
Manganese	red	2 lb. Manganese
Chrome	green	2 lb. Chromium

Important, too, is the knowledge that you can count on a dependable source of supply for these products. Our increased production capacity will permit us to meet the growing demands from old and new customers. We invite your inquiry.

FERRO - SILICON 50 - 75 - 85 - 90%
SPECIAL BLOCKING 50% FERRO - SILICON
LOW CARBON FERRO - CHROME SILICON
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FERRO - MANGANESE • BOROSIL • SIMANAL
BRIQUETS
SILICON • MANGANESE • CHROME
SILICO - MANGANESE

SALES AGENTS AND WAREHOUSES:

SAN FRANCISCO AREA — Pacific Graphite Company, Inc., Oakland 8, California.

LOS ANGELES AREA—Snyder Foundry Supply Company, Los Angeles 11, California.

MINNEAPOLIS AREA — Foundry Supply Company, Minneapolis, Minnesota.

MEXICO — Casco S. de R. L., Apartado Postal 1030, Calle Atenas 32-13, Mexico, D. F., Mexico.

SALES AGENTS, NO WAREHOUSES:

NORTHWEST AREA — E. A. Wilcox Company, Arctic Building, Seattle 4, Washington; Phone Mutual 1468.

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Ohio Ferro-Alloys Corporation
Canton, Ohio

Chicago Detroit Pittsburgh Tacoma Seattle
Minneapolis Birmingham San Francisco Los Angeles

BIRMINGHAM DISTRICT—Schuler Equipment Company, First National Building, Birmingham, Alabama.

HEY, CHARLIE - GOOD NEWS! they're delivering a load of that TOP QUALITY
100 LBS. NET WT.
NATIONAL
BENTONITE
BAROID SALES DIVISION
NATIONAL LEAD COMPANY

NATIONAL BENTONITE

A glad sight to many good foundrymen is an ample supply of National Bentonite, because many good foundrymen have learned they can rely on its consistently high quality. That's why, in foundry after foundry, you'll find National Bentonite helping to make molds that turn out better castings . . . molds which have high green strength and good hot strength both, molds that cut down the dangers of gas holes and blows. Many good foundrymen will tell you "Molds bonded with National Bentonite are *better* molds."

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American Steel & Supply Co.
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Asbury, New Jersey
Baroda & Page, Inc.
Kansas City, Missouri (main office)
Also—(Branches)
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Oklahoma City, Okla.
Wichita, Kansas
Dallas, Texas
Houston, Texas
New Orleans, La.
G. W. Bryant Core Sands, Inc.
McConnellsville, New York
Lloyd H. Canfield Foundry Supplies
1721 Minnesota Ave.,
Kansas City, Kas.
Combined Supply and Equipment Company
215 Chandler St.,
Buffalo 7, N. Y.
The Foundries Materials Co.
Coldwater, Mich. Also — (Branch) Detroit, Mich.
Foundry Service Company
North Birmingham, Alabama
James R. Hewitt
Houston, Texas
Interstate Supply & Equipment Co.
647 West Virginia St.,
Milwaukee 4, Wis.
Independent Foundry Supply Co.
6463 East Canning St.
Los Angeles, California
Industrial Supply Co.
San Francisco, California
Klein-Farris Co., Inc.
Boston, Massachusetts
New York - Hartford, Conn.
LaGrand Industrial Supply Co.
Portland, Oregon
La Salle Builders Supply, Ltd.
Montreal, Quebec, Canada
Marthens Company
Moline, Illinois
Carl F. Miller & Co.
Seattle, Washington
Pennsylvania Foundry Supply & Sand Co.
Philadelphia, Pennsylvania
Refractory Products Co.
Evanston, Illinois
Robbins & Bohr
Chattanooga, Tennessee
Smith-Sharpe Company
Minneapolis, Minnesota
Steelman Sales Co.
Chicago, Illinois
Stoller Chemical Co.
227 W. Exchange Ave.
Akron, Ohio
Wehenn Abrasive Co.
Chicago, Illinois
Mr. Walter A. Zeis
Webster Groves, Missouri

LITERATURE

(Continued from Page 86)

FOR FURTHER INFORMATION ON NEW FOUNDRY LITERATURE LISTED HERE USE CONVENIENT POSTCARD ON PAGE 86.

Spray Nozzles

19—Illustrated 4-page Folder 2386 describes water spray nozzles for cleaning all kinds of materials and screens. Nozzles do not clog, and can be easily installed. *Link-Belt Co.*

Carbon, Graphite Products

20—Products made of carbon and graphite in grades from porous to impervious are fully described in 20-page Catalog Section S-5005. Products include structural shapes, towers and accessories, furnace cathodes, and blast furnace linings. *National Carbon Co., A Div. of Union Carbide and Carbon Corp.*

Specimen Grinders

21—Grinders and surfaces for metallurgical samples are covered in 6-page booklet. Both belt and wheel types for wet or dry grinding are described. *Buehler Ltd.*

Radiography Source

22—Describing Cobalt-60 as a radiography source, 12-page booklet contains essential data, accessories, and typical radiographs. *Tracerlab Inc.*

Alloy Steel Castings

23—Containing over 100 illustrations, 32-page bulletin reports on steel, cast to shape, as a reliable engineering material. Contents cover data on properties and applications of cast nickel steels, classified by industrial fields; low temperature properties; abrasion resistance; depth hardenings; and welding. *International Nickel Co.*

Moisture Testers

24—Series of moisture testers, ovens, scales, drying dishes, and desiccators are presented in 12-page, multi-illustrated bulletin. *Harry W. Dietert Co.*

Foundry Equipment

25—Three-color, highly illustrated, 54-page Catalog 64 contains specifications for line of foundry equipment. Items include flasks and accessories, available in many styles; wheelbarrows and accessories; carts and trucks; casters and wheels; and similar units. All are completely described and illustrated. *Sterling Wheelbarrow Co.*

Electric Heaters

26—Portable and built-in electric air heaters—convection, blower, duct, and radiant types—and their controls are the subject of 4-page Folder F-1530. Application photos show equipment in actual use. *Edwin L. Wiegand Co.*

Quick-set Concrete

27—Typical uses and specifications for a concrete that sets to full service strength in less than 24 hours are presented in 20-page bulletin, "Lumnite." Concrete will set even in freezing weather. *Lumnite Div., Universal Atlas Cement Co.*

CHAPTER ACTIVITIES

(Continued from Page 83)

Guests at the meeting included: St. Louis District Chapter Chairman Ralph M. Hill, East St. Louis Castings Co.; Henry Meyer, General Steel Castings Co.; A.F.S. National Director A. L. Hunt, American Brake Shoe Co.; George Mellow, Liberty Foundry Co.; FEF Board Chairman Claude B. Schneible, Claude B. Schneible Co., Detroit; Webb Kammerer, Midvale Mining & Mfg. Co.; and John Williamson, M. A. Bell Co.

Cincinnati District

Marvin L. Steinbuch
The Lunkenheimer Co.
Public Relations Committee

NOVEMBER 12 MEETING, held at the Cincinnati Engineering Society, featured a talk by Werner B. Bishop, Foundry Products Division, Archer-Daniels-Midland Co., on *"Foundry Core Binders—Characteristics and Use."*

Mr. Bishop told how A-D-M set up its basic sand laboratory six years ago. Then he stated that since one learns more by seeing than by hearing, he would show a movie on his subject.

The movie, *"The A-D-M of Cores,"* revolves about a core room foreman who takes a trip to the A-D-M laboratories. This foreman learns how the laboratory tests and results can be utilized by the production core room. An enthusiastic discussion concluded the session.

Tri-State

J. G. Winget
Reda Pump Co.
Chapter Reporter

BANNER TURNOUT of 58 members and guests enjoyed the enlightening color film, *"The A-D-M of Cores,"* at the November 16 meeting, held at the Woodland Wing Country Club, Tulsa.

This film stresses two points: (1) The development of a consistent core-room practice from the receipt of specified core materials to the final delivery of cores to the molder, and (2) the application of laboratory tests on cores and core materials to actual production. A discussion period following the film was ably handled by A. C. Shaver of Archer-Daniels-Midland Co.

Central Illinois

G. F. Lloyd
Brass Foundry
Publicity Chairman

SECOND MEETING of the season, held November 5 at Murphy's, Peoria, Ill., with 140 members present, opened with Technical Chairman Henry Felten, Peoria Malleable Castings Co., introducing speaker of the evening George Anselman, Beloit Foundry Co., Beloit,

"FALLS BRAND" ALLOYS
AMERICA'S LARGEST PRODUCERS OF ALLOYS

"FALLS" NO. 11 ALLOY makes

HIGH ELECTRICAL CONDUCTIVITY COPPER CASTINGS

The manufacturing of high electrical conductivity castings is no longer restricted to a highly specialized group of foundries.

It is now open to all foundries. There are no secret arts or formulae.

"FALLS" NO. 11 ALLOY:
degasifies and deoxidizes the copper

protects the molten copper from re-oxidation up to and during the pouring operation.

Insuring
DENSITY, SOLIDITY, and HIGH ELECTRICAL CONDUCTIVITY CASTINGS.

Write for complete details.

NIAGARA FALLS
Smelting & Refining Division
Continental Copper & Steel Industries, Inc
BUFFALO 17, NEW YORK

Established 1887

K & R

No. DX5 - F5

Roll Core Wire Straightener

More than ever, due to the present shortage of material, this machine will pay big dividends reclaiming used core wire.

Size Mach.	Capacity SAE 1020	Prod. F. P. M.	Rec. Motor
DX5 Roll	1/8 - 3/8"	125	3 HP
F5 Roll	3/16 - 3/4"	115	7½ HP

NOTE: The above machines can be furnished with 8 or 9 rolls instead of 5 rolls.

K & R PRODUCTS

- ★ Straightening Rolls
- ★ Bending Rolls
- ★ Cold Roll Forming Machines
- ★ Gang Slitters
- ★ Flying Shears
- ★ Crimping Machines
- ★ Hydraulic Tube Benders
- ★ Hydraulic Bulldozers
- ★ Hydraulic Presses
- ★ Edging Machines
- ★ Special Metalworking Equipment

KANE & ROACH

Syracuse, New York

PATTERN and FLASK LUMBER from DOUGHERTY

WHITE PINE • MAHOGANY • PLYWOOD

Here's lumber that will cut pattern and flask costs because it is easier to work and has fewer flaws . . . resists cracking and warping . . . responds properly "under the knife". . . keeps pattern making time DOWN and quality UP.

Dougherty Perfection Pattern and Flask Lumber is the wisest buy for your shop!

PALLETS • SKIDS • ROLLERS
BOTTOM BOARDS • TOTE BOXES • CRATING • FILLETS
DOWELS • TANKS • WEDGES
BENCHES

MID-AMERICA'S LARGEST LUMBER SUPPLIER . . .

Diamond 1-1200

DOUGHERTY LUMBER CO.

Cleveland 5, Ohio

Wis., whose subject was *"Molding and Core Sands."*

Mr. Anselman discussed the importance of proper handling of various types of sand, and explained his theory of using the same fineness of sand throughout the core room and foundry. This eliminates any chance of mixing various types of sand on the molding floors, he said.

By this method the same fineness of sand is used for all types of molding, regardless of the size and weight of the casting, he concluded.

Central Indiana

Paul V. Faulk
Electric Steel Casting Co.
Chapter Reporter

DECEMBER 3 MEETING, with 95 in attendance, was held at the Athenaeum Turners Hall, Indianapolis, with Charles F. Maxwell, Christiansen Corp., Chicago, speaking on *"Metallurgy of Aluminum and Aluminum Foundry Practice."*

In explaining the history of aluminum in the foundry, the speaker outlined its uses, advantages and limitations and went into detail explaining uses of aluminum alloys.

Northern California

John Bermingham
E. F. Houghton & Co.
Chapter Reporter

DECEMBER 10 MEETING speaker was John Bogner, The Borden Co., who told of latest developments in shell molding. Progress in shell molding during the last year, he said, indicates that thermosetting resins are entering a period of great foundry popularity, particularly in the small casting field.

Passing around shell molding sections for audience inspection, Mr. Bogner went on to describe the best types of shell molding pattern equipment for securing maximum production at a minimum equipment expense.

The speaker also pointed out that on large production runs, shell molding effects considerable savings in sand and in time required for molding cycles. This, he said, increases production, saves metal, lowers cleaning costs and produces castings to closer tolerances.

A number of questions from the floor indicated that use of thermosetting resins in the chapter area foundries may open up new fields and permit solicitations of jobs hitherto considered out of the casting field.

Birmingham District

J. P. McClendon
Stockham Valves & Fittings, Inc.
Publicity Chairman

REPRESENTATIVES of the United States Pipe & Foundry Co. were very much in evidence at the chapter's November

meeting. Welcoming the principal speaker, Paul Arnold, were fellow USP & F foundrymen George Nauth and A. J. Fruchtl, who acted as toastmaster at dinner. Mr. Arnold discussed *"Development of Centrifugal Casting."*

Other U. S. Pipe foundrymen attending the meeting were Jack Austin of Chattanooga and A. L. Jones, W. J. Estes, R. L. Fox and C. P. Drake, all of the North Birmingham plant.

John F. Drenning, chapter secretary-treasurer, announced that present membership is 225 and said that Membership Chairman Donald C. Abbott has set 300 as his 1951 goal.

Central Ohio

Wilfred H. White
Jackson Iron & Steel Co.
Chapter Reporter-Photographer

ANNUAL DINNER DANCE, held December 8 at Brookside Country Club, Columbus, was in charge of Chapter Chairman W. T. Bland, Commercial Steel Castings Co., Marion.

A fine dinner was served to more than 50 couples and the ladies drew lots for the table flower arrangements. After dinner, the group enjoyed dancing to Harold Mauger's orchestra.

Northwestern Pennsylvania

Roy A. Loder
Erie Malleable Iron Co.
Chapter Reporter

MORE THAN 300 MEMBERS and guests attended the November 26 meeting to hear Dan Farrell, United States Steel Co., speak on the *"Three C's of Safety,"* in which he said the accidents don't just "happen," but have a definite cause in all instances.

Mr. Farrell presented several charts showing how accidents are plotted and analyzed to determine their causes. By this method, Mr. Farrell said, U. S. Steel has reduced its accident rate.

Following Mr. Farrell's talk was the dramatic skit, "Let's Pretend," in which the audience is subjected to simulated blindness as a means of stressing eye safety.

The Membership Committee reported 12 new members for the month and the Chapter's "Watch Us Grow" drive is gaining momentum. Goal is 200 members in 1952.

Michiana

A. J. Rumely, Jr.
LaPorte Foundry Co.
Publicity Chairman

Speaking before one of the largest groups to attend a meeting this year, Werner B. Bishop, Foundry Products Div., Archer-Daniels-Midland Co., Cleveland, discussed *"Control of Core Production"* and presented the sound color film, *"The A-D-M of Cores."*

(Continued on Page 94)

HAUSFELD
FURNACES

FOR "ALL-OUT" PRODUCTION
IN NON-FERROUS FOUNDRIES

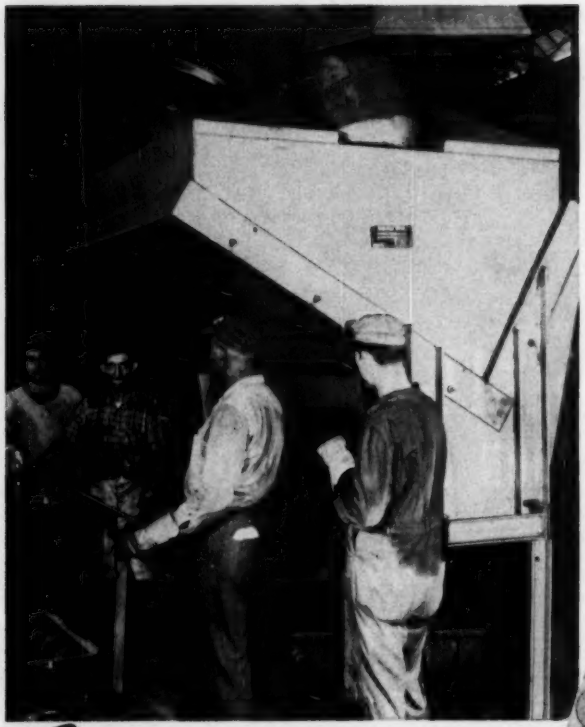
Provide the
Utmost in Speed
Production
and Safety

FURNACES FOR
BRASS • ALUMINUM • MAGNESIUM
AND ALL OTHER
NON-FERROUS ALLOYS

The Campbell-Hausfeld Co.
900-920 MOORE ST. HARRISON, OHIO

REDUCE EXHAUST AIR WITH CONTROLLED VENTILATION

Balanced Air Supply Saves Money



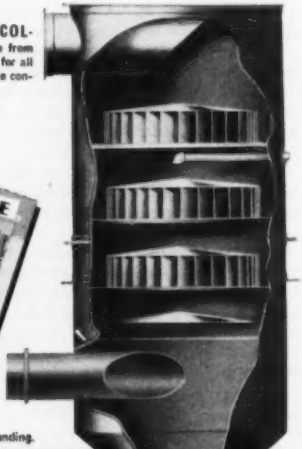
Lavish use of exhaust air can be expensive. When excessive volumes are used an unbalanced condition results in the foundry, setting up unwanted air flow patterns and causing waste of needed plant air.

Schneible "Compensating Air" hoods are designed with controls that allow the proper volume of supply air from either inside in summer to remove hot, dead air from under the roof, or outside in winter to conserve wanted power plant heat. Exhaust air volumes are also regulated to maintain building ventilation balance and more efficient use of all air.

Your local Schneible engineer has detailed information that will enable you to cut ventilation waste and save money—or write direct to

CLAUDE B. SCHNEIBLE COMPANY
P.O. BOX 502, ROOSEVELT ANNEX, DETROIT 32, MICH.

MULTI-WASH COLLECTORS available from 1000 to 36,000 c.f.m. for all dust, fume and smoke control applications.



Free

BULLETIN NO. 450

The latest information on standardized Schneible Uni-flo Hoods for Shakeouts, Pouring Stations and Mold Conveyors is now available for your files.

This comprehensive 16-page two color catalog includes pictures of each type of hood, tells how it functions and its outstanding features.

U. S. and Foreign Patents Pending.

SCHNEIBLE

FOUNDRY FIRM FACTS

Ford Motor Co., Dearborn, Mich., and **Cleveland-Cliffs Iron Co.**, Cleveland, soon will begin mining operations to produce 400,000 tons of concentrated iron ore a year from the Marquette Range at Humboldt, Mich. The crude ore will be mined from an open pit and passed through concentrating units which will produce a product substantially higher than the ores now being commercially mined in the Lake Superior region. A new company, owned jointly by Ford and Cleveland-Cliffs, will be formed to undertake the development and operation of the property.

Robinson Clay Product Co., Akron, Ohio, held its annual conference of plant superintendents in Akron. The superintendents discussed industrial relations, manpower, plant safety, conservation of materials and equipment, improvements in production methods, and changes in plant facilities.

Wheelco Instruments Company's Western Division Sales and Service Office will in the future be located at 2320 Milwaukee Ave., Chicago. Office will provide complete sales and service facilities.

Eaton Mfg. Co., Vassar, Mich., recently received the Group B, Foundries Division, National Safety Council Award in recognition of its achievement in reducing disabling injuries from July 1, 1950, to June 30, 1951.

Pangborn Corp., Hagerstown, Md., honored 77 veteran employees at the first annual dinner of its Quarter-Century Club. These men with 25 or more years' service were awarded gold watches.

Eutectic Welding Alloys Corp., Flushing, N. Y., has completed a new wing to house two new research laboratories. Staff will concentrate on developing welding alloys using fewer critical metals. Research on such metals as titanium is also planned.

National Lead Co., Baroid Sales Div., entertained over 1500 guests at the opening of its new headquarters in Houston, Texas, last November 16.

Taco West Corp., Chicago, recently appointed two new representatives in the eastern area. **Norman Bragar Co.**, Newark, N. J., will cover northern New Jersey, while **Gibson Engineering Co.**, Boston, Mass., will handle New England.

Minneapolis Electric Steel Castings Co., Minneapolis, conducted an open house in its plant, sponsored by the Twin City Chapter of A.F.S. Visitors were split into groups of 12 and guided by men from the technical and operating departments. Total attendance was 93. Of greatest interest to the visiting foundrymen seemed to be the cleanliness of the shop; atmosphere was kept clear by a reasonably small blower capacity. Many were surprised by the number and size of the buildings needed to store the large amounts of patterns used in such a jobbing foundry. As the groups completed their tour, they were served hot coffee and doughnuts and given the opportunity to visit and ask questions.

Whiting Corp., Harvey, Ill., through its Girls Club, held its annual Christmas party for all employees' children under 12 years old. Total turnout was 672. The party, a tradition since 1928, included a visit from Santa Claus, three professional entertainment acts, and color cartoons. Each child was presented with a gift at the end of the evening.

Charles H. Besley & Co., Chicago, changed its corporate title to **Besley Welles Corp.** on January 1, 1952. This move recognizes a 65-year association of the Welles family with this 76-year-old organization. Executive headquarters, abrasives sales offices, and cutting tool division will be established in Chicago. National sales will be handled direct from the plant at Beloit, Wis.

Minneapolis-Moline Co., Minneapolis, has just been awarded a contract for the reactivation and operation of a government-owned shell plant at New Brighton, Minn. Reactivation and equipment contract alone comes to $2,000,000. Operation of the plant, in stand-by condition since the end of World War II, will be under the management of W. C. MacFarlane, Jr., vice-president of Minneapolis-Moline.

Independent Foundry Supply Co., Los Angeles, recently moved into a new plant with 20,000 square feet under roof and a similar area of paved yard. New address is 6463 E. Canning St., Los Angeles 22.

Borden Company's Chemical Div. in Philadelphia expects to have its new $365,000 research laboratory completed by next June. Construction work is already under way. Adjacent to the company's molding compounds and industrial resins plant, the future building is to be one-story, made of steel, concrete, and glass and enclosing about 11,000 square feet of floor space for some 40 workers.

East Bay Brass Foundry, whose location remains unchanged, has been rezoned by the Post Office to the following mailing address: 1200 Chesley Ave., Richmond 4, Calif.

Cope and Drag Club Studies Sand

The Cope and Drag Club met December 6 and 7 in the laboratory of Carpenter Bros., Milwaukee, for a discussion of grain distribution and its effect on mold hardness. Jos. S. Schumacher, Hill & Griffith Co., Cincinnati, led the technical discussion with all members of the club spending an afternoon conducting and interpreting sand tests. Part of the second day's program was devoted to a visit to the investment foundry of Allis-Chalmers Manufacturing Co., West Allis, Wis.

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CHAPTER ACTIVITIES

(Continued from Page 91)

The meeting, attended by 127 foundrymen and their guests, was opened by Chairman S. F. Krzeszewski, who asked Membership Chairman Lester Pugh to introduce new members.

Chesapeake

Joseph O. Denko, Jr.
Arlington Bronze & Aluminum Corp.
Publicity Chairman

NOVEMBER MEETING audience heard A.F.S. National Director Fred G. Sefing, International Nickel Co., New York, give his views on *"The Trainee, the Journeyman and the Engineer in the Foundry Industry."*

Mr. Sefing pointed out that we have new labor saving equipment that reduces costs in foundry operation; but it is the loyalty of our workers that is worth more than all the machines we can buy.

The high schools, the trade schools, and the colleges provide a well of young men for all classes of help, but responsibility for getting the ball rolling rests with top management. More interest is shown by the student when he is contacted directly by the company itself, Mr. Sefing added.

Chicago

Dean Van Order
Burnside Steel Foundry Co.
Chapter Reporter

DECEMBER MEETING opened with Chairman Walter Moore, Burnside Steel Foundry Co., giving a brief resumé of the chapter's forthcoming "School of Melting," to be held beginning early this spring. School division chairmen will be: Steel, Clyde Wyman, Burnside Steel Foundry Co.; Gray Iron, Harold G. Haines, Howard Foundry Co.; Malleable, Cecil F. Semrau, Illinois Malleable Iron Co.; and Non-Ferrous, Fred Riddell, H. Kramer & Co.

Annual Ladies Night will be held February 23 at the Palmer House. Reservations are available from Harry Cullen, phone South Chicago 8-4000.

First speaker, A.F.S. National Vice-President I. R. Wagner, gave a short talk on the new A.F.S. 10-year Safety & Hygiene and Air Pollution Program.

A.F.S. Secretary-Treasurer Wm. W. Maloney reported on the coming A.F.S. International Foundry Congress & Show, to be held May 1 through 7 in Atlantic City.

Principal speaker D. A. Farrell, United States Steel Co., presented a talk on the "Three C's of Safety." Actual costs of lost time accidents are not always apparent upon first observation, Mr. Farrell said. He added that minor accidents outnumber major accidents 99 to 1 and that if these minor

accidents are reduced, the number of major accidents will decrease proportionately.

If, he concluded, the safety engineer applies the "Three C's of Safety"—Comprehension, Contact and Control—most accidents can be eliminated.

Michigan State College

Gene Rundell
Corresponding Secretary

NOVEMBER 17 MEETING drew the interest of the entire MSC Engineering School with a discussion and demonstration of shell molding.

Vaughn C. Reid, City Pattern Foundry & Machine Co., Detroit, spoke on the origin and development of shell molding and later exhibited a metal matchplate, dump box, contact pyrometer and specimens of shell molds currently in use at City Pattern.

Highlight of the meeting was a complete demonstration of the shell molding process by Mr. Reid and his foundry foreman, William Ochenski. Patterns were heated in an oven in the Foundry Laboratory and the shells were produced in the usual short time cycle. Assembled shells, surrounded by iron shot, were then poured with an aluminum-base alloy melted in the Laboratory by Chapter Chairman Wesley Hauschildt and Secretary-Treasurer Herbert Schlachter.

The demonstration was followed by a question-and-answer period in which Mr. Reid pointed out that the shell molding process lends itself to high production and may be developed into a pushbutton operation where smooth finish and dimensional accuracy are prime factors.

Saginaw Valley

Raymond F. Klawuhn
General Foundry & Mfg. Co.
Chapter Reporter

DECEMBER 6 MEETING featured an interesting discussion by Harold N. Bogart, Ford Motor Co., Dearborn, Mich., on *"Recent Foundry Developments."*

Mr. Bogart outlined phases of cupola melting, pointing out how little basic cupola design has changed throughout the years. In describing recent developments in this field, he said that water-cooled cupolas and continuous melting operations have proven very successful.

Air placement of refractories in cupolas is good practice, as it saves a great deal of manpower, encourages low erosion and makes for better metal control. Control by slag analysis is gaining in popularity and has become a near-permanent practice in many foundries, Mr. Bogart said, adding that oxygen enrichment in the blast also has definite advantages.

Preheated cupola blast has been used in this country at 350 to 400 F, but in

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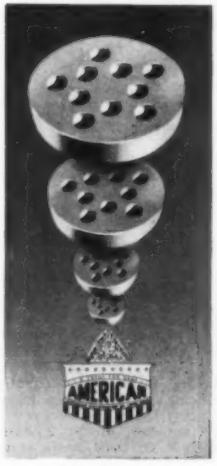

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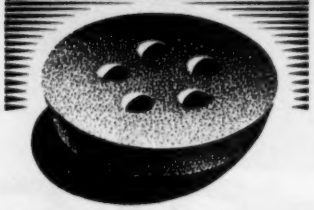

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foreign countries preheated blasts have reached 1100 F. With this high blast temperature, foreign foundrymen state they have produced high carbon irons from high percentage steel mixes, using no pig iron.

Mr. Bogart next turned his discussion to molding. Shell molding, he said, has decided advantages. This type of molding makes casting cheaper, more consistent, improves finish and reduces machining, he said, and has become popular because of less need for skilled help in machine shops. Shell molding also raises production rates.

NEW MEMBERS

(Continued from Page 62)

Stanley E. Koval, Fmn., Saginaw Valley Iron, G.M.C.
Donald J. Smith, Student, General Motors Institute.
Richard S. Smith, Jr., Personnel Dir., Saginaw Malleable Iron, G.M.C.

ST. LOUIS DISTRICT CHAPTER
Vernie Dye, Fdy. Fmn., General Steel Castings Corp.

SOUTHERN CALIFORNIA CHAPTER
Verner L. Barbor, Jr., Salesman, Exothermic Alloys Sales & Service, Inc.
Fred Dye, Permanent Mold Engr., Burndy Engrg. Co., Inc.
Wm. F. Hofer, Fmn., Independent Iron Works.

WESTERN MICHIGAN CHAPTER
William L. Haase, Planning Engr., West Michigan Steel Co.
Cliff Lonnee, Pres. & Gen. Mgr., Alloyed Grairon Castings Corp.

WESTERN NEW YORK CHAPTER
John G. Downing, Jr., Secretary, Kencroft Malleable Co., Inc.
Harold H. Judson, Plant Mgr., Kencroft Malleable Co., Inc.
Ernest R. Starkweather, E.C.A.

WISCONSIN CHAPTER
Thomas E. Baranck, Time Study, Grede Foundries, Inc.
M. E. Nevins, Pres., Wisconsin Centrifugal Fdy., Inc.
B. J. Witkowski, Fdy. Supt., Wisconsin Centrifugal Fdy., Inc.

STUDENT CHAPTERS

OHIO STATE UNIVERSITY
Howard Gallant
Richard Alan Peters

TEXAS A. & M.
Byron H. Anderson
R. B. Case
Charles Edward Russell
Charles E. Briesemeister
Albert Bennie Crownover, Jr.
Haskell L. Simon
Allen Scott Carter
Ted L. Mullinnix
Charles D. Unrue

INTERNATIONAL

Japan
Yahei Saito, Dr. of Eng., Niigate Engineering Co., Ltd., Chiyodaku, Tokyo, Japan.
Koichi Yoshihara, Ikegai Tatevama Mfg. Co., Tateyama City, Chi-ba-ken, Japan.

Netherlands
R. Reitsema, Director, Metals Research Institute T. N. O., Delft, Netherlands.

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NEW PRODUCTS

(Continued from Page 85)

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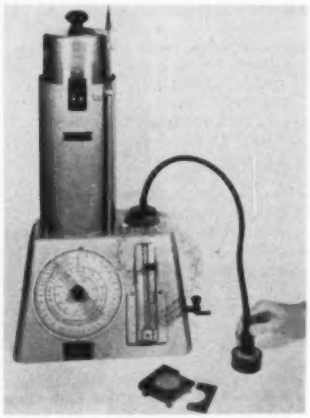
or weight factor. Tape adheres powerfully to both porous and smooth surfaces, and is particularly adaptable for wrapping small parts. *Behr-Manning Corp.*

Shell Molding Sand Tester

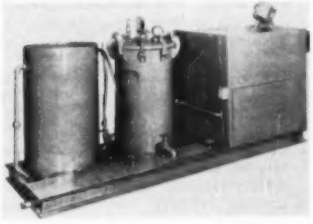
6—No. 360 shell mold permeability accessory is designed to be used in conjunction with a permeability meter or permmeter for reading and controlling



permeability of shell molding shells of varying sand, resin contents and flow characteristics. Unit reads A.F.S. permeability on a ¼-in. thick disc, and makes comparative permeability measurements on the mold itself. *Harry W. Dietert Co.*

Soldering and Brazing Gun

7—Soldering and brazing gun is adaptable to any type of manufacturing requiring these processes and is equally applicable to both special soldering jobs and production runs. Mogul gun deposits lead and tin base and silver solders or



brazing wires in liquid or semi-liquid form to a part moving at constant speed under gun nozzle. Soldering or brazing can be intermittent or continuous at any desired rate of speed up to 200 lineal fpm. Gun supplies soldering material in any desired quantity at a pin-point location. *Metallizing Co. of America.*

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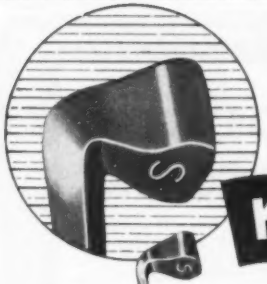

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FUTURE MEETINGS & EXHIBITS

- **Jan. 15—AFS Eastern New York Chapter,** Circle Inn, Lathams, N. Y. R. L. McIlvaine, National Engineering Company, Chicago, *"Foundry Layouts and Maintenance."*
- **Jan. 16—AFS Oregon Chapter,** Heathman Hotel, Portland. William Romanoff, H. Kramer & Co., Chicago, *"Brass and Bronze Foundry Practice."*
- **Jan. 17—AFS Detroit Chapter,** Leland Hotel, Detroit, C. V. Nass, Beardsley and Piper Div., Pettibone Mulliken Corp., *"Mechanization in Molding."*

Jan. 18—Malleable Founders' Society, Cleveland. Annual Meeting.

- **Jan. 18—AFS Texas Chapter,** Western Hills Hotel, Fort Worth. L. S. Beinke, Plaster Process Casting Co., *"Aluminum and Plastic Pressure Plates."*
- **Jan. 21—AFS Quad City Chapter,** Ft. Armstrong Hotel, Rock Island, Ill. H. K. Briggs, Miller & Co., Chicago, *"Cupola Practice."*
- **Jan. 25—AFS Tennessee Chapter,** Hotel Patten, Chattanooga. F. S. Brewster, Harry W. Dietert Co., *"Foundry Sands."*
- **Jan. 26—AFS Western New York Chapter,** Sheraton Hotel, Buffalo, Ladies Night.
- **Jan. 28—AFS Northwestern Pennsylvania Chapter,** Moose Club, Erie, Pa., Fred G. Sefing, International Nickel Co., *"The Foundry's Responsibility in an Educational Program."*
- **Feb. 1—AFS Western New York Chapter,** Harry Kessler, Sorbo-Mat Process Engineers, *"Gating and Risering."*
- **Feb. 4—AFS Metropolitan Chapter,** Essex House, Newark, N. J. Clyde A. Sanders, American Colloid Co., Chicago, *"Sands and Binders."*
- **Feb. 4—AFS Chicago Chapter,** Chicago Bar Association, Wm. T. Bean, Jr., Detroit, *"Good Casting Design—On Purpose,"* and Ralph L. Lee, General Motors, *"People As They Come and Are."*
- **Feb. 4—AFS Central Indiana Chapter,** Athenaeum Turners Hall, Indianapolis, C. T. Marek, Purdue University, *"Casting Design for Economical Production in the Engineering Curriculum."*
- **Feb. 4—AFS Central Illinois Chapter,** American Legion Post, Peoria, Ill., Richard Herold, The Borden Co., *"Shell Molding."*
- **Feb. 5—AFS Rochester Chapter,** Hotel Seneca, Rochester, N. Y., Wesley C. Stott, A. P. Green Firebrick Co., *"Refractory Materials for the Foundry."*
- **Feb. 7—AFS Canton District Chapter,** Mergus Restaurant, Canton, Royal G. Tobey, Eastman Kodak Co., *"Non-destructive Testing with X-Ray and Radium."*
- **Feb. 7-8—AFS Wisconsin Regional Foundry Conference,** Schroeder Hotel, Milwaukee, sponsored by the AFS Wisconsin Chapter and U. of Wisconsin.
- **Feb. 8—AFS Southern California Chapter,** Rodger Young Auditorium, Los Angeles. Clyde A. Sanders, American Colloid Co., *"Foundry Sands."*

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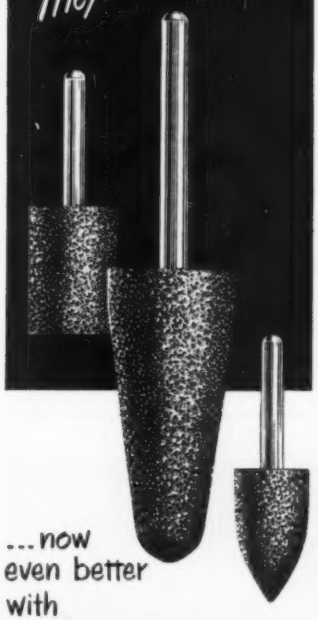

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- **Feb. 8—A.F.S. Eastern Canada Chapter,** Mt. Royal Hotel, Montreal. Bruce L. Simpson, National Engineering Co., *"Development of the Metal Castings Industry."*
- **Feb. 11—AFS Michiana Chapter,** Indiana Club, South Bend, Ind. Harry Gravelin, Ford Motor Co., talk and film: *"Iron Ore to Motive Power."*
- **Feb. 11—AFS Central Ohio Chapter,** Columbus, Ohio, William T. Bean, Jr., Industrial Electronics, Inc., Detroit, *"Good Casting Design—On Purpose."*
- **Feb. 12—AFS Twin City Chapter,** Covered Wagon, Minneapolis, Richard Herold, Borden Co., *"Shell Molding."*
- **Feb. 13—AFS Toledo Chapter,** Toledo Yacht Club. *"International Night,"* A.F.S. Secretary-Treasurer Wm. W. Maloney.
- **Feb. 14—AFS Northeastern Ohio Chapter,** *"Pattern and Foundry Engineering."*
- **Feb. 14-15—Foundry Educational Foundation,** Technical and University Advisory Committee Conference, Hotel Statler, Cleveland.
- **Feb. 15—AFS Texas Chapter,** Ben Milam Hotel, Houston, Texas. Tom Barlow, Eastern Clay Products, Inc., *"Casting Defects as Related to Foundry Sand."*
- **Feb. 18—AFS Quad City Chapter,** Fort Armstrong Hotel, Rock Island, Ill., Bruce L. Simpson, National Engineering Co., *"Development of the Metal Castings Industry."*
- **Feb. 19—AFS Eastern New York Chapter,** Circle Inn, Lathams, N. Y. L. D. Pridmore, International Molding Machine Co., *"Core and Mold Blowing."*
- **Feb. 21-22—AFS Southeastern Regional Foundry Conference,** Tutwiler Hotel, Birmingham, Ala., sponsored by the AFS Birmingham District and Tennessee Chapters and University of Alabama Student Chapter.
- **Feb. 23—AFS Chicago Chapter,** Palmer House, Chicago, Ladies Night.
- **Feb. 25—AFS Northwestern Pennsylvania Chapter,** Moose Club, Erie, Pa., J. Allen Wickett, Monsanto Chemical Co., *"Some Aspects of the Shell Mold Casting Process."*

Feb. 25-26—Materials Handling Conference, Purdue University.

- **March 3—AFS Chicago Chapter,** Chicago Bar Association. Round Tables.

March 3-7—American Society for Testing Materials, Spring Meeting, Cleveland.
March 18-19—Steel Founders' Society, Annual Meeting, Edgewater Beach, Chicago.

- **May 1-7—AFS International Foundry Congress & Show,** Atlantic City, N. J.

May 22-24—American Society for Quality Control, Syracuse, N. Y., Convention.
June 16-17—Malleable Founders' Society, Annual Meeting, Homestead, Hot Springs, Va.
June 23-27—American Society for Testing Materials, Annual Meeting, New York.
Sept. 8-12—Instrument Society of America, Cleveland, National Instrument Conference and Exhibit.
Oct. 16-17—Gray Iron Founders' Society, Annual Meeting, Cleveland.
Oct. 16-18—Foundry Equipment Manufacturers' Association, The Greenbrier, White Sulphur Springs, W. Va.
Oct. 20-24—American Society for Metals, National Metal Congress and Exposition, Philadelphia.

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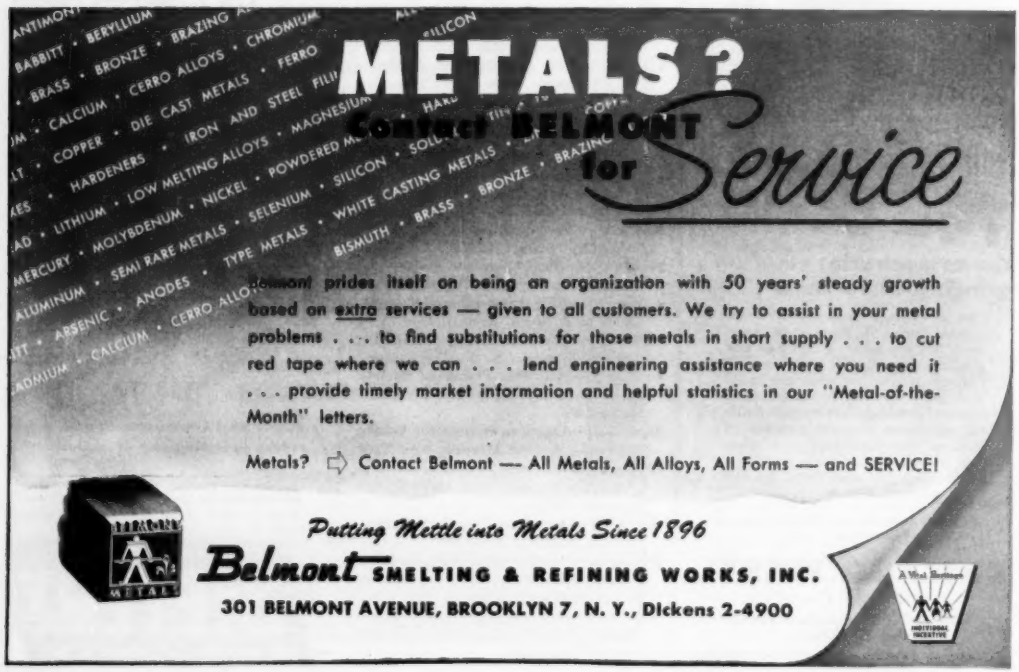
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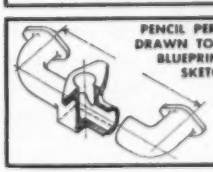
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